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THE PRINCIPLES OF
ITS RELIEF BY GLASSES

Daniel Bennett

BY

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New York
THE MACMILLAN COMPANY
LONDON: MACMILLAN & CO., Ltd.
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Norwood Press
J. S. Cushing & Co. – Berwick & Smith
Norwood Mass. U.S.A.

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PREFATORY NOTE

In 1888 the author of this volume published a little book entitled *The Determination of the Necessity for wearing Glasses.* It was one of a series, by various authors, upon different subjects in medicine and surgery. It had a very favorable reception and large sale. The publisher, however, has lately retired from business, and transferred the copyright to the author with the suggestion that the book be republished, since it was still constantly asked for.

On undertaking to revise this volume I found that it required a complete rewriting, so great has been the advance in our knowledge of the proper prescription of glasses, especially in the matter of simplicity in method. I have, therefore, carefully rewritten the book, introduced illustrations, and very much enlarged it. I have also ventured to change the title, as I think the present one explains its object a little better than the former. I hope this manual may be found a reliable guide to the student and practitioner in ophthalmology, and that it may also be of interest to those educated people and general practitioners who, without having a special interest in the subject, wish to know the principles upon which the prescription of glasses is based.

New York,
February 1, 1899.

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DEFECTIVE EYESIGHT

CHAPTER I

MEASUREMENT OF VISUAL POWER

First attempts to accurately estimate the visual power.—Jaeger's and Snellen's test-types.—The choice of glasses on scientific principles made practicable by Donders.—The invention of the ophthalmoscope.—Apparatus required for testing vision.—Conditions of the eye requiring glasses.—The varieties of astigmatism.—The ophthalmometer.—Asthenopia.—Definitions of the conditions to be discussed in the following chapters.

IT was not until the year 1854, that any systematic attempt was made by the medical profession to accurately measure the eyesight. During this year, Alfred Smee, in England, and Eduard Jaeger, in Austria, published a set of test-letters, or test-types, for this purpose. These tests were convenient, but insufficient. They consisted merely of a collection of paragraphs in type, ranging fr the smallest that is made, to very large lett such as are used in hand-bills. They gave idea as to how far each size should be seen a normal eye, and beyond the statement of th ability of the patient to read fine or coarse type fluently or slowly, it was not possible with them — valuable as they were, and still are — to give an exact idea of the visual power of a given person. In 1868, Snellen, of Holland, published a set of test-types, which virtually solved the problem of measuring and registering vision.

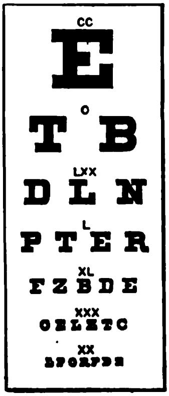

FIG. 1

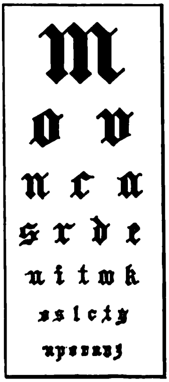

FIG. 2

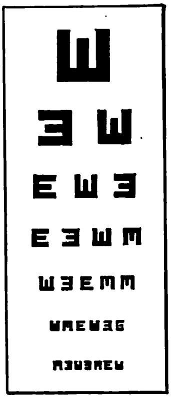

FIG. 3

ellen's types are founded upon the principle
determining the smallest angle in which the
n of a given object may be accurately recog-
l.[1] Snellen's test-types are large Latin letters,
osed in a quadrangle. The height and breadth
these letters are, as far as possible, five times

---

des Auges, Snellen and Landolt; Graefe
nd III, Abtheilung I, p. 5.

that of each of the twenty-five small quadrangles, of which each letter is formed. The numbers above them, CC, C, LXX, L, XXX, XX, indicate the distance in Parisian feet at which these letters can be seen at an angle of 5′. The visual power is then expressed by a formula, as follows: The visual power V, equals the distance at which the letters should be seen, divided by the distance at which they are actually recognized by the patient. For example, if a patient sees letters that are normally distinguished at 20 feet, at only 10 feet, the formula would be $V = \frac{10}{20}$. In the latter part of this book is found a specimen of Jaeger's and Snellen's test-types, which, with these remarks, will make this part of my subject perfectly clear. Although Snellen's test-types, like Jaeger's, include also a set of graduated type for testing reading power, the general practitioner, and, in many instances the specialist, will be sufficiently accurate, if he limit his collection of test-letters to Jaeger's f near vision, and Snellen's for the distance. convenient, matters should be so arranged th the visual power may be recorded as found wi Snellen's letters at a distance of 20 feet.

There is a large field open for further investigation on this subject. A very interesting case, in which Dr. Frank N. Lewis was an expert witness, came to the knowledge of the writer, which explains this remark.

There was a collision on the Hudson River which, it was claimed, was caused by the want of sight of the pilot of one of the vessels. It was found that his eyes were perfect, so far as any disease was concerned, but that he had but $\frac{20}{100}$ vision, which could, however, be made $\frac{20}{20}$ with correcting glasses. He was not in the habit of wearing correcting glasses. Of course, his position did not demand that he should read letters on the boats of the river, but simply that he should see lights. The question turned upon the point as to whether a man with $\frac{20}{100}$ vision, could see a colored light far enough to be able to avoid collision.

It must be understood, then, that the examination of a patient's ability to read test-letters inside of a building, is only an index of his capacity for reading p[illegible] sewing, and so forth. There [illegible] various oth[illegible]ters, in which visual tests, [illegible] than th[illegible] colors, require amplification. But for ordinary practice, the examination indoors, as indicated, will be sufficient.

Jaeger's test-types are used for testing the capacity of reading and the like, while Snellen's series is used for registering the actual visual power. In others words, Jaeger's test-types, especially numbers one, two, and three, are adapted for fitting glasses with which to read, while the test-card hung at 20 feet, will furnish an accurate record of the visual power. As will be seen later on, the tests for fine type are chiefly valuable in presbyopia; that is to say, for choosing a glass to be used in ordinary employments, reading, writing, sewing, and the like, at near points. A shorter distance than 20 feet may be made available for testing vision. Javal utilizes half the distance by testing from the image of the letters reflected in a mirror.

The metric system has been adapted to the measurement of vision, and some practitioners prefer it, but I continue to find Snellen's original system very suitable to all cases, and I see no advantage in the change that has been made.

In Snellen's letters thus modified, the largest letters of the series should be seen at 40 metres, the next in size at 35 metres, and so on, at intervals of 5 metres, until those which subtend an angle of 5 minutes at 5 metres are reached. If the patient can read the 5-metre type at 5 metres, the vision is registered as $\frac{5}{5}$ or I; but if only able to read the 30-metre type at 5 metres, the vision is $\frac{5}{30}$ or $\frac{1}{6}$. It seems to me more simple to measure by feet for registering visual power.

If a patient cannot see No. XX at 20 feet, he may see No. C or CC at that distance. Then his vision will be $\frac{20}{100}$ or $\frac{20}{200}$. In case he is not able to recognize even No. CC at 20 feet, he will, if he have any more than perception of light, see it at some lesser distance, for example at 7 feet, when $V = \frac{7}{200}$. Of course the illumination of the room, which is often dependent upon the weather, and other conditions, influence the visual power to a considerable degree. These should be allowed for, or artificial light should always be used. But it is to be remembered that absolute accuracy in measuring visual power is not always attainable, even with the latest modifications and combinations of Snellen's system. Here, as in other matters, we must be content with an average statement. In general terms, we may say that a person who reads No. I Jaeger fluently, from 4 to 8 inches from his eyes, and No. XX of Snellen's test-types at 20 feet, has normal vision.

An example of an unnecessary refinement are cards, with black backgrounds. They are said not to try the patients as much as those in common use, because black is restful to the eye, especially when under the influence of a mydriatic. Since the use of mydriatics is scarcely ever necessary in testing vision, this advantage is not a great one. These test-letters on black backgrounds, are only mentioned to indicate what the author means by undue attention to very insignificant details in the tests of vision.

It is quite possible to be too punctilious in the matter of the measurement of vision. I do not mean to say by this, that we ought not to be very careful to make each comparative test by the same degree of illumination, and at the same distance, and also to use in all doubtful cases various sets of letters to avoid any self-deception on the part of the examiner, but I do mean, that many of the modifications of the shape of test-letters, and the adoption of the metric system, are not at all necessary for an accurate register, and a subsequent proper fitting of glasses.

Intelligent school children readily learn series of letters, even in the few moments devoted to examining them in the consulting room. Unless two or three sets of letters are at hand, errors may arise from this source — not only with children and young persons, who will make an effort to learn the letters for the purpose of gratifying mischievous tastes — but also in testing adults. Several series of test-letters are now furnished by opticians. It is also to be remembered, as shown by Pomeroy and Schweigger, that a certain facility in reading test-letters is soon acquired. It is not proper to assume that a person actually sees better at his second visit because he then reads $\frac{20}{30}$, when he before read only $\frac{20}{40}+$; that is, $\frac{20}{40}$ and one or two letters of $\frac{20}{30}$. He may read that much better, by the little practice and experience acquired in the examination.

The signs + and – are appended to records of vision, to indicate as follows: If a patient's vision be $\frac{20}{40}+$, he can read all of No. XL, and one or two of No. XXX. If it be $\frac{20}{40}-$, he can read nearly all, but not quite all of No. XL, and so forth. Many persons, especially young persons, can read No. XX at a greater distance than 20 feet, but $\frac{20}{20}$ is an average representation of normal vision in average illumination. The inability to read the whole of a line may also be indicated, as suggested by Norris, by putting interrogation marks in numbers corresponding to the letters not correctly given at the end of the line, thus $\frac{20}{30}$?? or $\frac{20}{30}$? The beginner in the study of diseases of the eye, should spend some time in patiently testing vision. The results obtained by a beginner are often very inaccurate, simply from his want of experience in making an exact test.

If the practitioner be provided with three sets of Snellen's test-types, and with a set of convex and concave spherical and cylindric glasses, he may in a very little time, even if he has no knowledge of the use of the ophthalmoscope, determine whether a patient's real or apparent loss of vision depends upon an error of refraction, that is, upon an abnormality in the shape of the eye, or upon disease. Furthermore, a practitioner with a little leisure and a good ophthalmoscope, may learn to diagnosticate opacities of the lens and vitreous humor, and gross changes in the optic papilla and retina in a few weeks. This being done, he will make substantially accurate examinations for determining visual power. Too much difficulty has been ascribed to this whole subject. To learn the optical principles upon which depend the use of the ophthalmoscope, the formation of images, and the manufacture of lenses, is a matter requiring months and years of close study, but to know how to use the ophthalmoscope and the ophthalmometer and to adjust correcting glasses, need not necessarily require a long time in a fairly well educated practitioner.

It is only since the date mentioned at the opening of this chapter, that glasses or spectacles have been generally prescribed by a surgeon or oculist. Even the *oculists* of the days prior to this, did not attempt much more than to send their short-sighted and presbyopic patients to an optician to determine if glasses would do any good.

The opticians to whom these people were sent were usually mechanics, with no knowledge of the structure or functions of the human eye, knowing, at the most, how to grind convex and concave lenses. As a matter of fact, people who wore glasses selected them themselves, with a little crude help from the man who sold them.

As an illustration of what has just been said, the practitioner may be interested in a reference to a treatise on the eye, which was a standard work in Great Britain, France, Germany, and the United States in 1855–58.[1]

In speaking of glasses for myopia, the author remarks: "When a near-sighted person wishes to be fitted with concave glasses, the simplest and surest plan is to try a series of them, at an optician's shop." Then some rules are given, but in the want of positive knowledge of what myopia really depended upon, these rules were not valuable, and probably were very little heeded by the optician.

The invention of the ophthalmoscope by Heinrich Helmholtz, made it possible to change all this unscientific inexactness into scientific accuracy. As soon as the media of the eye could be examined, and the retina and entrance of the optic nerve studied, the proper classification of its refractive errors and accommodative failures were made.

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[1] *A Practical Treatise on the Diseases of the Eye,* by William Mackenzie, M.D.

The types for testing vision followed. Then Donders presented the whole subject to the profession, very much amplified by his own discoveries, in his famous work upon the *Accommodation and Refraction of the Eye.*[1]

Not only were the indications for the use of spherical glasses very plainly set forth in this book, but the great discovery of the value of cylindric glasses for astigmatism, was also made known. A careful study of the work, with a little clinical experience, soon enabled the practitioner who knew the anatomy and physiology of the eye and the use of the ophthalmoscope, to properly adjust glasses for the patients who might be benefited by them. The haphazard and insufficient methods of the opticians were replaced by exact and scientific measurement of the refraction and accommodation of the eye, by skilled men who could distinguish between incipient or advanced inflammatory or other morbid changes constituting disease, and purely optical conditions, which may be modified by lenses.

The determination of the proper use of lenses for the improvement of sight thus followed closely upon the invention of the ophthalmoscope. No exactness in the determination of the value of glasses was possible until the lens, vitreous humor, choroid, and retina could be in each case examined to determine if opacities or other morbid changes existed in them. The mirror which illuminates tissues which had heretofore been visible only after post-mortem changes had occurred, besides enabling us to study the diseases of the interior of the eye, made it possible to accurately measure its length. Ten years after the invention of the ophthalmoscope, surgeons in the large cities and towns of all civilized countries, were adjusting glasses for eyes whose prototypes had been considered as subjects of incurable diseases, or had been given over to the unscientific care of jewellers and opticians.

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[1] New Sydenham Society, 1864.

As I have said, it is not absolutely essential that the practitioner should know how to use the ophthalmoscope in order to adjust glasses properly for quite a large number of cases requiring them. These cases are those in which the usual tests show that there is no actual disease of the eye. It is, however, of the highest importance that every one who intends to give any special and exact attention to all conditions of the eye requiring glasses, should first be able to examine the eye by this means, else he may conclude that eyes are diseased and need positive medical or surgical treatment which require only correcting lenses.

The fitting of glasses upon scientific principles was never at all generally adopted, until Donders by his discovery of the general existence of hypermetropia, and Snellen by the promulgation of his series of tests, made it possible for every educated physician to soon learn the proper method. Up to this time, all fitting of glasses had been purely a matter of trial of what one could see: if presbyopic with convex glasses, if myopic with concave, with no standard of what was even approximately normal vision.

I lay a little stress upon this, not intrinsically important point, because it has been claimed in certain quarters that it is to opticians, and not to physiologists and physicians, that the world is indebted for the present advanced state of knowledge of the use of glasses. I was once an expert witness in a case where there was an attempt made to show that we were so greatly indebted to manufacturing and commercial opticians, that they had a right to be enrolled as a separate profession under the absurd name of *refracting opticians.* The learned profession of medicine with very slight assistance from other scientists may claim all the discoveries necessary for the prescription of glasses. The names of Bacon, Airy, Young, Helmholtz, Donders, Snellen, Jaeger, Javal, include them nearly all. Every practitioner of medicine who is remote from an expert in ophthalmology, ought to be able to make tests of the visual power, and in perfectly clear, uncomplicated cases of presbyopia, myopia, and hypermetropia to prescribe glasses.

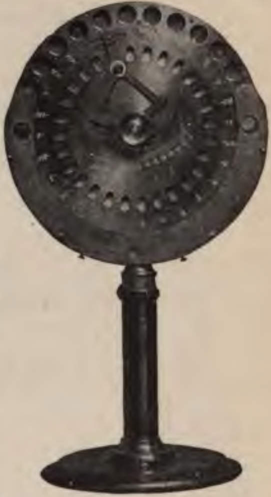

FIG. 4.—JAVAL'S SUBSTITUTE FOR THE TRIAL CASE[1]

It is highly proper that such men should learn the fundamental principles at the basis of fitting glasses to myopic and presbyopic patients at least. By a little study and practice, they could do sufficiently well to drive out the travel-

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[1] Photograph by W. T. Georgen.

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ling opticians who give improper advice and palm off useless glasses on unsuspecting people.

The apparatus required is:

I. Three or more sets of test-letters for examining the visual power at the distance of 20 feet.

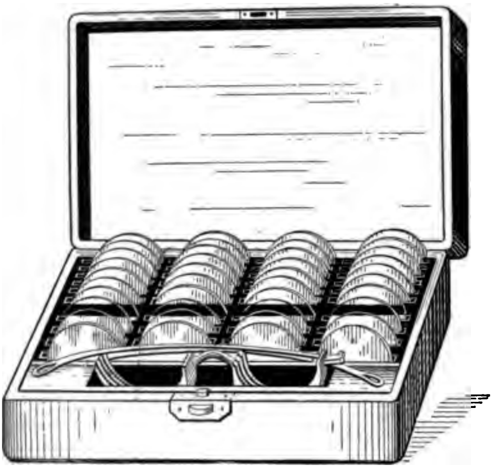

FIG. 5

II. A set of test-letters for examining the visual power at a reading distance.

III. A double set of convex and concave spherical glasses running from glasses of 0.50 to 12 diopters.

IV. A prism of 6°.

V. Four single concave and convex cylindric glasses 0.50, 0.75, 1, 1.50, 2, diopters.

VI. A double-grooved trial frame.
VII. One opaque disk.
VIII. One red disk.

These glasses and test-types may be procured at any optician's in the large cities. The whole apparatus will cost about twelve dollars and a half.

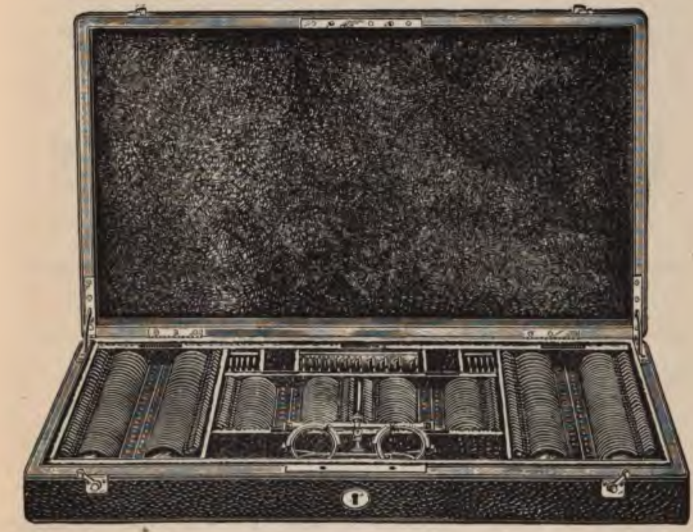

FIG. 6.—COMPLETE SET OF TESTING GLASSES

The smaller case is by no means sufficient for the practitioner who desires to be able to accurately fit any given case. But it will be found sufficient for him who simply desires to determine whether or not the symptoms of the patient, are probably due to the need of glasses.

I am speaking, in what has just been said, of what is needed by the general practitioner who desires only to adjust glasses to cases uncomplicated with any disease of the cornea, lens, or deeper parts of the eye. The specialist, as has been intimated already, should possess and know how to use the ophthalmoscope and also the ophthalmometer.

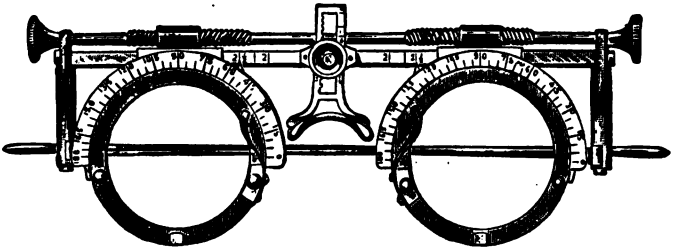

Fig. 7.—Frame for Trial Glasses

He also will require a set of testing glasses ranging from 0.60 to 20 diopters in spherical glasses and from 0.50 to 6 diopters in cylindrics.

Classification of Eyes requiring Glasses

All the conditions of the eye requiring the use of glasses may be resolved into the following:

I. Presbyopia.
II. Hypermetropia.
III. Myopia.
IV. Aphakia.
V. Paralysis of the ocular muscles.

The reader may be at first surprised that astigmatism, the condition of unequal refraction in different meridians of the same eye, does not appear in this classification. A little study will show, however, that every case of astigmatism may be resolved into one of the following conditions:

1. *Hypermetropic astigmatism. Where the eyeball is too short in one meridian only.*
2. *Compound hypermetropic astigmatism. Where the eye is too short in both meridians, and shorter in one than in the other.*
3. *Myopic astigmatism. Where the eyeball is too long in one meridian, and of the proper length in the other.*
4. *Compound myopic astigmatism. Where the eye is too long in both meridians, and longer in one than the other.*
5. *Mixed astigmatism. Where the eyeball is too long in one, and too short in another meridian.*

6. *Irregular astigmatism. Where the same meridian is of different refractive power in different parts.*

It is thus seen that astigmatism is but a variety of either myopia or hypermetropia, or a combination, if I may so speak, of two kinds of refraction in one and the same eye. It has nothing to do with a difference in refraction of the two eyes, as seems to be often supposed.

Presbyopia, the sight of old age, needs no subclassification, although the reader will readily comprehend that a presbyope may be also myopic or hypermetropic. To myopia, astigmatism may also be added as well as to hypermetropia, while astigmatism may exist with no other refractive error. It should also be mentioned at this point that one eye may be entirely different in refraction from its fellow. For example, one eye may be astigmatic while the other is not, one may be hypermetropic and the other myopic, and so forth, in all variety of variations. This is *Anisometropia.*

THE OPHTHALMOMETER

Since the time of the ophthalmoscope the greatest addition that has been made to the armamentarium of the oculist, or of the practitioner who wishes to accurately adjust glasses to the human eye, is the ophthalmometer. The ophthalmoscope made it possible to classify the various errors of refraction. Without it, Donders could not have made his great discoveries. But this invention, immeasurably great as it is, left much to be desired, especially as to the determination of the presence or absence of astigmatism. Helmholtz supplemented his work of the invention of an ophthalmoscope, by making an instrument which should measure the corneal curvature, horizontal, vertical, and oblique. But the ophthalmometer of Helmholtz, was so constructed as to be fitted for use only in a physiological laboratory. If the practitioner tried to use it, he consumed so much time, and he was obliged to have a room so carefully arranged as to light, that the instrument was not at all practicable for the ordinary work of the practising ophthalmologist. After many years of labor with the Helmholtz instrument, Dr. E. Javal of Paris, assisted by one of his pupils, Schiotz, at last perfected the ophthalmometer, so that it has become a thoroughly convenient and accurate instrument, whose management is very easily acquired by any practitioner who will give it careful attention under an instructor, for a short time every day for a few weeks.

ASTHENOPIA

It was supposed by Donders, that he had found the source of all forms of asthenopia in errors of refraction. It is probably a fact that what may be defined as true asthenopia, does always depend upon an error of refraction, but there is a form of inability to continue to use the eyes, that seems to be especially frequent in the United States, which does not depend upon an error of refraction, for it may exist without any such error. For many years the belief has prevailed in a large professional circle, that there is a form of asthenopia dependent on want of balance of the ocular muscles, and muscular asthenopia has played a great part in the ophthalmic writings of our time. This view is but a revival of an erroneous opinion promulgated by the French school before the invention of the ophthalmoscope. It was not fully given up after this, even by such teachers as Donders: for insufficiency of the internal recti, and muscular asthenopia, dependent upon this insufficiency, continued to be constantly discussed by Albrecht von Graefe. In the light of his own discoveries, which, had they been carried to their logical sequence, would have soon put an end to the investigations of muscular insufficiencies and their supposed consequences, Donders gave a very grudging consent to the continuation of this view of the importance of so-called "muscular asthenopia." It has been reserved for our time to produce those, of whom the present author is one, who, after a fair trial of restoration of the so-called "balance" or "equilibrium" of the ocular muscles by prisms and tenotomies, have ceased to believe in the existence of any such condition as "muscular asthenopia." I divide asthenopia into two classes:

First, that dependent upon refractive conditions of the eyeball.

Second, that dependent upon constitutional conditions.

Those who are interested in the full discussion of this subject, I beg to refer to my *Treatise on the Eye*.[1] For the purposes of this manual, it is sufficient to say at this point that if a practitioner

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[1] New York, Wm. Wood & Co.

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finds no positive error of refraction, he is not justified in supposing that the asthenopia depends upon the eye, but he should seek for other causes, such as anæmia, one of the neuroses, diabetes, malaria, or other diseases affecting the general system. The tests for the muscular equilibrium are valueless, simply because a given number of persons, who have no asthenopia whatever, will furnish about the same results from tests, as those who cannot continue to use their eyes without discomfort or pain. Asthenopia really deserves no separate classification in an ophthalmic treatise. It is but a symptom of an error of refraction, or of a diseased condition of the eye, or of the general system. When it is a symptom of an error of refraction, the error is usually astigmatism of the hypermetropic variety, or hypermetropia pure and simple. It less frequently exists as a consequence of uncorrected myopia, or of presbyopia. There is a large contingent that is not relieved by glasses however skilfully chosen, or by drugs however aptly prescribed, but which remain as incurable as many other neuroses. Besides, a certain degree of hypermetropia and of hypermetropic astigmatism may exist with full use of the eyes, without pain or other inconvenience. We cannot, therefore, conclude that we have found the source of asthenopia, or of headache, because we detect an error of refraction of a low degree.

Asthenopia has, therefore, no claim to a separate place in classification, since it is almost always associated with an error of refraction, and because asthenopia, *weak sight*, is merely the expression for such symptoms as watering of the eyes, inability to continue to use the eyes on account of smarting, burning, or the like, headache, nausea, and so forth.

I am sure my readers will not for a moment confound a set of symptoms like these, which are comprehended under the term asthenopia, with refractive and accommodative errors, as asthenopic patients may be hypermetropic, or myopic, or astigmatic, or have no marked error of refraction. Yet it is still better to classify asthenopia separately, for there is a uterine asthenopia connected with disease of the uterus or ovaries, as well as asthenopia depending upon general causes, without an error or refraction, or at least without depending upon one.

For a better understanding of what is to follow, I may add the definitions of all the conditions about to be discussed.

1. *Presbyopia.*—A disease, or failure in accommodation, or in the power of adjusting the eye to vision at different distances; a recession of the near-point.

By near-point, is meant the nearest point at which minute objects such as fine type can be seen.

2. *Hypermetropia.*—Insufficient refractive power of the eye, usually dependent upon shortening of the antero-posterior diameter of the eyeball.

3. *Myopia.*—Excessive refraction of the eye, usually dependent upon elongation of the antero-posterior diameter of the eyeball; recession of the far-point.

4. *Astigmatism.*—Unequal refraction of two meridians of the same eye, or of one and the same meridian, usually dependent upon an abnormal curvature of the cornea.

5. *Asthenopia, or Weak Sight.*—Inability to continue to use the eyes without pain, watering, headache, or other symptoms. It may depend upon an error of refraction, a disease of some organ of the body or other conditions, which have weakened the muscles of accommodation and convergence, the ciliary and the internal recti.

CHAPTER II

PRESBYOPIA

The history of the invention of convex and concave glasses. — The function of accommodation. — Two rival theories. — Recession of the near-point, the essential mark of presbyopia. — The great advantage of correcting astigmatism, occurring in conjunction with presbyopia. — Combinations of errors of refraction with presbyopia. — How far the general practitioner may go. — Second sight. — Illustrative cases.

EVER since glasses were invented by Salvinus Armatus or Roger Bacon, in the thirteenth century, they have been used for presbyopia, or the sight of old age.

It is very doubtful if Friar Bacon actually invented convex lenses for presbyopia, but the authorities declare that he knew at least of their use and method of construction. As to the Italian *Salvinus Armatus*, the most that we know of his connection with the discovery of the proper use of glasses for the sight of old age, is that upon his tombstone is said to be inscribed "The Inventor of Spectacles."

It is tolerably certain that convex glasses for presbyopia began to be used A.D. 1200, and that concave lenses for the relief of myopia soon followed.

It is, therefore, about six hundred years since spectacles are mentioned in European literature, although according to John Green[1] they were in common use, both concave and convex, among the Chinese before the opening of trade with Europe. They were made of transparent stone, of a color like that of a strong infusion of tea. Seneca and Pliny, also quoted by Green, speak of the magnifying of objects by a glass globe filled with water. The Arabians also knew of the properties of lenses. The Latin version of the works of Alhazen, also quoted by Green, *l.c.*, describes the magnifying power of the segment of a sphere, but Roger Bacon, about 1267, appears to be the first writer in our tongue who actually describes a convex glass as an assistance to the eyes of old people in reading. A Florentine, *Salvino degli Armati*, and *Alessandro della Spina*, a Dominican monk of Pisa, divide the honors of being the inventor of spectacles. That the former was the inventor is said to be inscribed on his tombstone. It was reserved for our century, however, to explain their use, and vastly increase the extent of their usefulness. Indeed, there cannot be said to have been any scientific mode of prescribing spectacles, until the time of Donders's publications, which were printed in the Dutch and German languages a little more than forty years ago, and in English two or three years later. The Emperor Nero may have had compound myopic astigmatism, as ingeniously argued by Green, which he corrected by looking through a concave precious stone, but very few but emperors had any assistance to their eyesight by glasses, until the period of Friar Bacon and the rival Italians.

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[1] *Reference Hand Book of the Medical Sciences*, Vol. IV.

A great many inexact and unobservant people do not learn from their experience that they have become presbyopic until long after forty-two, or forty-three, or even more, years are reached. They ascribe their failing sight at a convenient distance, — if women, their inability to thread a needle, — to poor type, badly made needles, poor light, and various other things, until at last a friend's glasses casually taken up, or some fortuitous circumstance convinces them that glasses are what they need. Then there is also a not inconsiderable class who from motives of vanity, push off what they call the evil day of wearing glasses, until they are reminded, as was Mr. Rufus Choate by the learned judge, who suggested, as he was struggling to get his manuscript at a point far enough distant to enable him to read it, that he had better get a pair of tongs to hold the papers, or a pair of glasses with which to read them.

Carter[1] suggests that one of the reasons that presbyopes object to putting on glasses, may be that tradition has told them that opticians in the former days saw certain people with the disease known as glaucoma, who came to them very frequently for a change in glasses. They naturally finally became blind, for glaucoma was then generally unrecognized and always incurable, and they associated their loss of sight with the use of too strong glasses. Popular prejudice has also been excited on this subject by various articles in important journals, written by those who had no exact knowledge of the eye, inveighing against the use of glasses. Nowadays this prejudice seems to have passed away. Except in the case of presbyopes, the pendulum swings too far on the other side.

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[1] *Good and Bad Eyesight*, p. 87.

Convex glasses are equally useful for the correction of hypermetropia and of presbyopia; but the two conditions, although requiring the same means of relief, are by no means the same condition. They should not be confounded. Presbyopia is a failure in the accommodation power of the eye, while hypermetropia is an insufficient refractive power. This is usually owing to a shortening of the antero-posterior diameter of the eyeball. In some cases, it may depend upon insufficient refractive power of the crystalline lens alone.

THE MECHANISM OF ACCOMMODATION

The ciliary muscle acting upon the crystalline lens is the agent of accommodation. The usually accepted theory of accommodation, which is not without its opponents, is, that in vision for near objects, the lens becomes thicker by the action of the muscle upon the suspensory ligament.

Helmholtz is the author of this theory. The fact that the lens becomes thicker on accommodation for near objects was, however, incontestably proven before Helmholtz showed how this was accomplished. His theory is that the contraction of the ciliary muscle causes the zone of Zinn to advance, and thus to diminish the traction exerted by it upon the crystalline lens. The lens then becomes more convex, especially on its anterior surface, by means of its own elasticity.

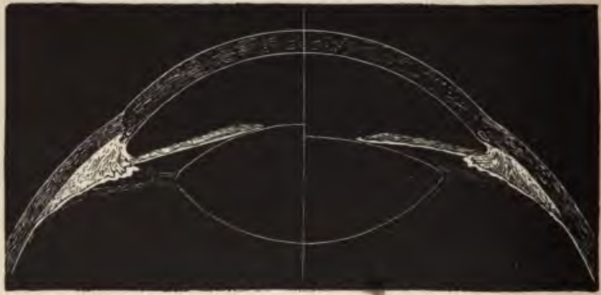

FIG. 8.—THE HELMHOLTZ THEORY OF ACCOMMODATION, AFTER ARLT

When the ciliary muscle becomes relaxed from a cessation of the innervation for accommodation for near objects, the ciliary process becomes tense, and stretches the zonula, which now flattens the lens by exerting traction upon it in the direction of the equator.

Tscherning[1] is the chief opponent of Helmholtz's theory. His ideas of the mechanism of accommodation are summed up by him as follows:

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[1] Transactions, International Congress of Ophthalmology, Edinburgh, 1894.

By the contraction of the ciliary muscle, the anterior part of its deep layer exerts a traction on the zonula which, on the one hand, gives to the crystalline lens the shape that it assumes during accommodation, and, on the other, gives it a tendency to move backward. At the same time, the posterior end of the muscle, by its traction on the choroid, produces an increase in the tension of the vitreous humor, which keeps the lens in position.

Presbyopia is a weakening of the power of accommodation for near objects. It is assumed that the ciliary muscle becomes weaker as time goes on, and that the lens also becomes less elastic, and at forty-two to forty-five he who is not myopic, usually becomes unable to read fine type at 8 inches from the eye. I say usually, because there are occasionally people over fifty years of age who are not myopic, and yet can read the finest type at 8 inches, with the naked eye. *The recession of the near-point of vision is the distinguishing mark of presbyopia.*

This recession is caused by the two factors just mentioned, weakness of the muscle and rigidity of the lens. It is not caused, as was formerly supposed, by flattening of the cornea.

Fine type, brilliant, is used to test the near-point.

Widely as it is known among all people that sight for near or fine objects fails in old age, or even in middle life, presbyopia is very often a surprise even to educated and intelligent people, and they are shocked to find that they can no longer read fine print, or if women, see to thread a needle. Whenever clear vision at a proper distance becomes difficult, it is proper to seek the aid of glasses. They become to the overburdened muscle of the eye, as much of a necessity as food to the empty stomach, or a cane or crutch to him who has not the full power of his legs. There is no advantage in delaying their use. As has been said, it is at about the age of forty-two, that presbyopia makes itself markedly manifest, that is, it is at about this age, that the near-point of distinct vision for fine print and the like, recedes to such an extent as to make it difficult to read or sew. To this, however, there are exceptions; the myope who begins life with an eyeball that is too long, does not require glasses to read with until very late in life, and sometimes, if the elongation of the eyeball be considerable, not at all. To this category, belong many of the apparently marvellous cases of aged persons who read and write without glasses. Their power to do this, is no evidence that they had particularly good eyes.

If a person be astigmatic in early life, so as to require a cylindric glass for relief of asthenopia, when presbyopia comes on, the spherical glass required by age and the recession of the near-point, must be added to the cylinder worn or required for the correction of the corneal astigmatism.

Many persons do not learn that they are hypermetropic until they become presbyopic. They are able by extra or extreme use of the ciliary muscle, to overcome this congenital shortness of the eyeball, until the fatal boundary line of forty-two to forty-four years is reached. Then they find their accommodative power so much weakened, or their lens so rigid, that they can no longer see perfectly at a distance, or at the best they require a much stronger glass for reading or sewing than their fellow presbyopes who are not hyperopic.

Again, people who are markedly hypermetro in early life, in other words, those whose eyeballs are too short, are apt to require glasses for reading at an earlier age than forty-two, and they are obliged to wear stronger glasses than those who are simply presbyopic. Both the hypermetropia and the presbyopia must be neutralized; for example, a person who is hypermetropic to such a degree that a glass of one diopter, say of 37 inches' focal distance, is required to neutralize it, will require for reading the glass that is necessary for the correction of the hypermetropia, together with that required for the presbyopia without hypermetropia.

An example may make this clearer. AB, æt. 20, can only see $\frac{20}{20}$ by means of a glass of plus one diopter. But with this glass he sees not only at a distance, but also for reading. At forty-two, presbyopia comes on. He then continues the one diopter for distant objects, but for reading he requires that glass with an added + 0.50 D or + 0.75, the glass that an emmetropic presbyope would require. The same is true of many cases of corneal astigmatism. Its existence is not known until the first examination of the eyes by an expert for glasses for reading. If the astigmatism be as much as one diopter, its correction is usually a great addition to the comfort in wearing convex glasses.

Experience has pretty conclusively shown, that it is better to put on glasses when reading fine print becomes difficult without them, than to endeavor to postpone the day of wearing them. To delay the adjustment of glasses for presbyopia, is simply to limit one's occupations and lessen one's comfort.

The procedure of adjusting glasses for uncomplicated presbyopia is exceedingly simple. Most of civilized mankind accomplish it for themselves, without the aid of oculists. There is, however, a small degree of risk in this, for glasses are sometimes changed for what is supposed to be only rapidly failing accommodation, when serious disease, hardening of the eyeball — *glaucoma* — is impending.

It is a symptom which should be carefully looked into, when people of fifty years of age or upward, find themselves frequently changing their glasses, or attempting to get a better number every few months. Glasses in presbyopia, do not, as a rule, require changing oftener than once in two, three, or more years.

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The first rule for testing for presbyopia is the following:

The vision for the distance, say at 20 *feet, is accurately estimated; each eye is tested separately.* If it be $\frac{20}{20}$ or $\frac{20}{20}-$, no apprehension need be felt that anything beyond presbyopia is to be encountered, except latent corneal astigmatism. If the vision for the distance be of this power, the patient should next be seated by a good light, and the convex glass sought with which he *is able* to read "No. I Jaeger," or the like, at 8 inches from the eye, each eye being separately tested. It is not the glass with which he is able to read No. I Jaeger, *fluently and easily,* at that distance, for this is generally not an easy task for any but myopes and very young persons, but that glass with which, with some pains, he is able to make out all the words of a few sentences distinctly and with tolerable fluency. This glass will usually be found to be the proper one for work upon near objects.

It is not always easy to make this test, for some patients refuse for some minutes to believe that this distance of 8 inches is merely, so to speak, a ng distance, but they insist that they "never read at that distance," and decline to make the effort, but by making this distance the standard for the test, as has been said, the proper glass is usually found. In addition to this test, it is well to cause the patient to read for a few moments with the glasses chosen, in an ordinarily printed book, held at the distance most agreeable to him.

At this point the expert will do well even if V $= \frac{20}{20}$, to measure the cornea with the ophthalmometer. If as much as one diopter of corneal astigmatism with the rule, or 0.25 diopter against the rule, be found in each eye, it will be usually better to correct the astigmatism also, by adding the appropriate cylinder. But in the chapter upon astigmatism this point will be more fully discussed.

If, however, the vision be not $\frac{20}{20}$, or nearly so, an attempt should be made to make it normal before a glass is chosen for near work. If simple hypermetropia be the cause of the trouble, we shall have no difficulty, for at forty-two the accommodative power is so weakened that spasm is not to be feared. A weak convex glass is soon found with which vision becomes perfect, and this, as has been indicated, is added to the one usually required for beginning presbyopia. In general terms, it may be said that a person beginning to wear convex glasses on account of presbyopia requires one of 48 inches' focal distance, of 0.75 diopters.

If the vision cannot be made $\frac{20}{20}$ by spherical glasses, those ground from a cylinder should be tried, and if astigmatism is found, the patient will find much comfort from the addition of the one needed to correct the astigmatism, to the spherical one required to correct the presbyopia. If the astigmatism be hypermetropic, the axis of correction will be the same for both far and near; but if the astigmatism be myopic, that is if the eye be too long in one meridian, the axis of the correcting cylinder for reading, should be at right angles to the one required for distant vision, and it should be a convex cylinder instead of a concave.

The convex cylindrical glass corrects the meridian that is not myopic. The myopic meridian either requires no glass at all, or one that is weaker; for that meridian, being too long, has its near-point at a nearer distance than the emmetropic meridian. An example will be given at the end of this chapter, which will illustrate and explain this.

Many presbyopes are never properly fitted with glasses, because the astigmatism is overlooked. It is absolutely essential, if comfort is to be had in wearing glasses for near work, that astigmatism, if present, and if equal to one diopter with the rule, whether it be hypermetropic or myopic, should be corrected. If the patient have hypermetropic astigmatism, a glass is virtually added to one meridian. If we have myopic astigmatism, a glass is subtracted from the meridian.

If a presbyopic patient cannot be made to see well, say $\frac{20}{20}$ or $\frac{20}{20}$– with any glass, we may be sure that there is some obscurity of the media, opacity of the cornea, or cataract, or a disease of the perceptive apparatus. This, of course, can only be positively determined by examination of the cornea by means of a lens and artificial light, and of the lens and vitreous humor, retina, and so forth, by the ophthalmoscope. The general practitioner who has not learned to use this instrument will be obliged to stop at this point in these cases; but he can at least tell his patient that he is not merely *presbyopic*, but also *amblyopic*, and that no glasses will enable him to see clearly.

The method formerly adopted, of simply testing the capacity to read near at hand, should never be practised.

If in testing for presbyopia the distant vision be not first measured, we have no fixed point for observation. Many persons who cannot see more than $\frac{20}{40}$, or even $\frac{20}{50}$, can read No. I Jaeger or *brilliant* type with more or less fluency. In other words, the visual capacity can only be accurately measured when that for distant vision is regarded.

Paresis of the accommodation, as is well known, sometimes occurs as a result of diphtheria, acquired syphilis, injuries, and so forth. In this case convex glasses are often of service while recovery is taking place, or even if the paresis be permanent.

A presbyopic patient will require stronger glasses as time goes on. But no fear need be felt, if no organic disease exist in the eye, but that a glass may always be found to correct the error of accommodation.

The same rules apply for changing glasses as for first putting them on. At first presbyopes will only require glasses in the evening and for small type, or for work upon fine objects, but soon they will be required by day. Then the glasses first chosen may be used by day and a stronger pair at night.

The accommodative power is hardly established before it begins to decline in vigor. The near-point of distinct vision for fine objects, begins to recede in early youth, and when threescore and ten are reached, it becomes one with the far-point — there is no accommodative power, no range of accommodation. This cannot be entirely referred to a want of contractile power of the ciliary muscle, unless it is unlike all the other muscles of the body. Their contractile power does not begin to diminish as soon as it is exerted. Hence many are inclined to think that the failure in accommodative power is due almost, if not entirely, to loss in the elastic quality of the lens.

It may be said in general terms that a presbyope who is not hyperopic or myopic, will work his way up from a glass of 0.75 diopters to one of 4 diopters, which latter glass will be in use from the age of sixty on until the end of life. Hypermetropes often reach a glass of 6 diopters, 6 inches' focal distance, before accommodation ceases.

When one comes to examine patients with presbyopia, — that is to say, people who ask for glasses with which to read, and who have never had any complaint to make of their sight until forty to forty-five years of age were reached,— it is surprising that so many of them, are found to have some deviation from a so-called emmetropic eye. A low degree of hypermetropia cannot be considered abnormal, nor can a low degree of corneal astigmatism, but, eliminating these two classes, a great many presbyopes will be found to be myopic in one or both eyes, amblyopic in one eye, astigmatic in both eyes, or one, and of a different degree in one from the other, and so on, through all the various conditions that constitute departures from the ideal eye. And yet the vast number of these people have had no trouble until they came to the time of life when presbyopia appears. All this goes to show, that the human race can get on very well, and have no particular trouble with an eye that is far from ideal.

The writer of this little volume, as will be seen in various references, has no sympathy with the doctrine that eyes must conform to a certain ideal, and be made standard or emmetropic eyes by glasses in order to insure ease in their use or to avoid evil consequences to their general health. Very great deviations from the normal, occur without any particular harm to the capacity to use the eyes or to the general health.

ILLUSTRATIVE CASES

The following cases were tested since the importance of the ophthalmometer has been recognized, but the physician who has no ophthalmometer will have no difficulty in most cases of presbyopia, in making the proper tests without its use. The accommodation of a person of forty-two or more years of age, is not sufficiently active to produce spasm.

Presbyopia, faculative hypermetropia, exceedingly good vision, a small degree of corneal astigmatism against the rule.

John M., age 48, president of a business association, has worn glasses for reading for some years, is now wearing, right and left eye, + 1 D with a prism, 2°, base inward. His vision is $\frac{20}{10}$– in each eye. He can read the same with or without + 0.50. He can only read No. I Jaeger with + 2 D for each eye. The ophthalmometer shows that he has a quarter of a diopter of corneal astigmatism, against the rule. He was ordered the glass with which he could read the finest type at 8 inches, with a glass added to it which would nearly correct his corneal astigmatism. The following is the formula: R + 2 D = 0.50c, 180°.

Presbyopia, with corneal astigmatism. Patient complains of headache and pain in her eyes. Astigmatism had not previously been corrected. Relief.

Mrs. Michael S., age 53, right vision $\frac{20}{40}$, left $\frac{20}{40}$, becomes $\frac{20}{20}$ in each eye with the addition of + 75c, 180°. She can read No. I Jaeger at 8 inches with + 4 combined with the above-named cylinders. The ophthalmometer showed that she had corneal astigmatism of 0.50, against the rule. The glasses were comfortable.

Presbyopia with hypermetropia.

Miss B. H., age 50, vision with the right eye, $\frac{20}{50}$, with + 1.25 becomes $\frac{20}{30}$ +. Left eye, $\frac{20}{70}$, with + 1.50 becomes $\frac{20}{30}$ +. She can read No. I Jaeger at 8 inches with a + 4 glass. The ophthalmometer shows that there is half a diopter of astigmatism with the rule. This is disregarded, since it is corrected by the crystalline lens. Glasses were ordered as above indicated.

Presbyopia. Patient did not put on glasses to read until she was 46. *Excellent vision for the distance. Typical case of presbyopia.*

Miss M. M. Y., age 46, never has worn glasses. Is in very poor health,—of late has cried very much, and thinks she cannot read as well as she formerly did. Her vision was found to be $\frac{20}{20}+$ in right eye, $\frac{20}{20}-$ in the left. She could not see any better with any glass. She could only read No. I Jaeger with + 1.50. She had half a diopter of corneal astigmatism, with the rule. + 1.50 advised.

Myopia with presbyopia. Weak concave glasses for the distance, with weak plus glasses for reading, make the patient comfortable.

Mrs. P. M. V., 48 years of age, has been near-sighted many years. Her right vision is $\frac{20}{200}$; with $-1\frac{1}{2}$ D it becomes $\frac{20}{30}$. Left is $\frac{20}{200}$; with − 1.75 it becomes $\frac{20}{30}$. She has 0.50 D of corneal astigmatism, with the rule. She reads No. I Jaeger at 8 inches with + 1.25 in the right eye, with 1 in the left. These glasses were ordered.

Hypermetropia with presbyopia. Lady of 40 *requires a glass of* 36 *inches' focal distance, to read fine type at* 8 *inches.*

Mrs. H. G., age 40. For the past year this patient has been troubled by pain in the eyes and head, and when she uses her eyes at night her sight blurs. The vision is $\frac{20}{20}$ in each eye. With a glass of 48 inches' focal distance, it is the same. She can only read No. I Jaeger at 8 inches with a $+\frac{1}{36}$, 1 D. Her near-point without glasses is about 12 inches.

This case illustrates what has been said in regard to the addition of a glass to correct the hypermetropia to the one required for the presbyopia. A person of 40, who is not hypermetropic, ought still to be able to read fine type at 8 inches without glasses, but a slight degree of hypermetropia renders this impossible.

Presbyopia complicated with myopic astigmatism in a man of 49.

S. B., age 49. This patient requires a concave cylindric glass of 30 inches' focal distance, the axis of the glass being at 100° for the right eye, and 75° for the other, to get his best vision for the distance $\frac{20}{40}-$ on a dark day, which would be $\frac{20}{30}$ on a clear day.

For reading, we correct the emmetropic meridians as we would for an emmetropic presbyope, by putting a convex glass cylindric before them, while we leave the myopic meridian, when the near-point is still at 8 inches, or less, uncorrected. For the distance, the only meridians to be corrected are the myopic ones. Thus, if the vertical meridian be myopic, it will require no correction for reading, while the opposite one, which is emmetropic, or of the normal length, will. This shows why in cases of myopic astigmatism we put a convex cylindric glass with the axis at right angles to the one used at a distance, over the eye for reading.

A case of presbyopia accompanied by manifest hypermetropia. The following is a good illustration of the strong glass that a person with presbyopia, in connection with manifest hypermetropia, is obliged to wear for reading, as time goes on.

Mrs. B. L. N., age 56. The patient put on glasses at 36, on account of hypermetropia. They were + 1 for each eye, and they made her vision

$\frac{20}{20}$, right eye, and $\frac{20}{20}+$, left eye. She is wearing +4 D for reading. With that, she can only read No. I Jaeger at 10 inches. With +4.50, she can read it at 8 inches, and this glass is ordered. She has only half a diopter of astigmatism, with the rule.

The next case is almost exactly like the preceding, except that the patient is 11 *years younger.*

January 18, 1898. R. V. T., age 47. He has $\frac{20}{20}$ vision with glasses, but, to secure this, he has to wear +1 D on the right side and +2.25 on the left. He reads No. I Jaeger with +2.50 on the right eye and with +4 on the left, and these glasses are ordered for him, in addition to his glasses for the distance.

Presbyopia without hypermetropia, or, at least, hypermetropia of a very low degree.

Mrs. T. M., aged 47. She has $\frac{20}{30}+$ vision in the right eye, not improved by glasses. She reads as well with +50 as without them, so that she may be said to have faculative hypermetropia. She has, by the ophthalmometer, half a diopter of astigmatism, with the rule. She reads No. I Jaeger at 8 inches with +2.50 on the right side and + 3 on the left, and these glasses are ordered for her.

A case complicated with lenticular changes,—commencing cataract,—and yet very good sight is secured with glasses.

January 24, 1898. Mrs. M. F. D., age 79. Her vision is $\frac{10}{200}$ without glasses, but with + 3 D it becomes $\frac{20}{50}$. With both eyes open, $\frac{20}{40}$, with the same glass. She reads No. I Jaeger at 8 inches with + 7 D. On the right side there is half a diopter of astigmatism, with the rule. On the left side there is no astigmatism. *There are minute opacities in each lens.* Glasses were ordered, both for far and near.

The following case illustrates a complication of myopic astigmatism with presbyopia. It also illustrates the ease with which it is corrected.

Mrs. W. J., age 47. The patient complains simply of trouble in reading. Her vision with the right eye, without a glass, is only $\frac{20}{50}$, with the left, $\frac{20}{30}$. The ophthalmometer shows that she has 1 D of astigmatism, against the rule, in the right eye, and in the left, 0.25 against the rule. The use of a minus cylinder, 1.25, at 80°, in the right eye, makes the vision $\frac{20}{20}$. In the left, -50 at 100°, makes the vision $\frac{20}{20}+$. In the right eye she reads No. I Jaeger with plus cylinders, with the axes exactly reversed from those used for the distance. In the left eye, she reads No. I Jaeger with a plus cylinder, axis reversed; that is, 10° added to a $+75$, and with these glasses she reads very comfortably.

The value of the ophthalmometer in such a case as this is very marked, but, as has been said in the earlier part of this chapter, while it requires more time, it is not at all difficult to detect the astigmatism, and find the proper axes for its correction, with Snellen's test-types, and cylindrical glasses, in any patient over forty years of age.

Presbyopia. No inconvenience from the eyes until the near-point receded.

R. A. J., age 45. Has lately observed that he is obliged to hold his paper very far off in the evening in order to read. His vision is $\frac{20}{15}$ with each eye, but he can only read No. I Jaeger at 14 inches. With $+1.25$ he reads it at 8 inches. The ophthalmometer shows on the right side 0.50

with the rule, on the left, 25 against the rule. If he had 25 against the rule in both eyes, I should certainly have prescribed cylindric glasses, whether he accepted them or not. But, as his vision was excellent, and he lived an outdoor life, never having had asthenopia, for the present I was satisfied with giving him a glass with which he could read No. I Jaeger at about 9 inches. I did not order one with which he could read it at 8 inches, because he had been holding his paper at such a distance, for such a time, that I did not think he would tolerate the glasses. He therefore was ordered, right and left +1 D. The time may come when, his general health not being so vigorous, he will prefer to have the astigmatism in the left eye corrected for the reading glasses.

It would require an examination of several hundreds of cases of people who now choose glasses for themselves for reading, as time indicates that they need them, to prove whether or not there is a large percentage of pure presbyopia. I am inclined to think there is not,— that examinations of these people would show the variations that are indicated in the cases taken from my own note-book; that is to say, I think it would show that a large proportion of them were hypermetropic, or had a low degree of astigmatism or myopia. But this question must remain unsettled until some authority undertakes an examination of a thousand presbyopes who are simply aware that they cannot read fine print without convex glasses. I suggest it as a profitable field for inquiry.

SECOND SIGHT

This is a popular term for the condition in old age, which enables its subjects to read without glasses. It is not a blessing when it occurs, as it is usually a stage in a disease of the lens — a swelling. This of course makes the eye myopic. It is a condition of things that is very convenient so long as an opacity of the lens does not result. This artificial myopia may occur in one eye, and the other remain with insufficient refraction, so that a convex glass is needed in near work for one eye, and none at all for the other.

Second sight then usually depends upon myopia either congenital or acquired. Very many myopes think they have excellent vision for the distance, when they really see badly. It is no proof that a person has good visual power because he thinks that he has.

What is meant by this is, that nothing but exact testing of the eyes by an expert, will furnish reliable evidence as to the eyesight. It is a frequent experience to hear persons boasting of their far vision, when an examination shows that their acuteness of vision is actually far below the normal. A low degree of myopia very readily escapes the observation of the person affected, or even a high degree, if in one eye only. Either of these conditions will compensate for a considerable degree of failure of accommodation, and postpone the day for convex glasses for reading. Some stress is laid upon these facts, because of the number of cases of second sight that are triumphantly adduced as occurring in persons who were never near-sighted. Only a test showing the contrary, is proof that they are not.

CHAPTER III

MYOPIA. SHORT-SIGHTEDNESS

An error in the refraction of the eye long recognized. — Faulty name, but impossible to substitute a better one. — Myopia essentially a disease, but more marked in some cases than in others. — Congenital or acquired. — Prejudice against its correction. — Cases. — Simple test for its detection. — False myopia. — Prevention of short-sightedness. — Illustrative cases.

We now leave the subject of failure of accommodative power, and turn to refractive conditions. These are, of course, independent of muscular contractility and of the elasticity of the lens, and depend upon organic changes or want of development in the eyeball itself. Myopia, like presbyopia, has been recognized, and to a certain extent scientifically managed for centuries. Glasses have been prescribed for its relief, and, on the other hand, ignorant persons have pronounced anathemas upon the use of glasses to relieve it, as they have against those for presbyopia. Hence, to this day, there is to be found in many quarters a prejudice against the use of correcting lenses, even when it is shown that vision without them is not nearly up to the normal standard.

Much of the nomenclature of medicine, is unfortunate in the light of the knowledge of our time. Nowhere is this more marked than in the name *myopia,* from *μύειν,* to blink, from the habit of blinking which many myopes have. This they do to lessen the number of rays of light that enter the eye, by decreasing the size of the pupil. Short-sightedness is a good English name which ought to be generally adopted by English-speaking people. It defines the condition of things in myopia fairly well. The vision in myopia is good for a short range, one longer or shorter according to the degree of myopia. Short-sightedness expresses this condition very well. Donders proposed the name *Hypometropia,* but this, although etymologically correct, is so like *Hypermetropia,* that its general adoption would be apt to result in confusion and in many errors.

The name *brachymetropia* (*βραχύς, short; μέτρον, measure;* and *ὄψις, vision*), while correct, makes no headway against *myopia,* which is probably fixed in scientific literature.

Gustavus Adolphus was near-sighted, and it is said that he lost his life at the battle of Lutzen, because he had no correcting lenses, and got among the soldiers of the enemy, thinking them to be his own. One of the most successful Union generals of our late war, more fortunate than the great Swedish commander, was wise enough to recognize the fact that he was astigmatic, and with the aid of an ingenious Connecticut mechanic, caused a pair of cylindric glasses to be ground for himself, not knowing that they were generally to be procured. With these, he said to me, he was enabled to be a much better soldier than without them. Yet a great many people — and by no means are they always unintelligent or uneducated — prefer to see as they always have done, "in a beautiful haze," as one lady once described her short-sighted vision to me, than to be startled by seeing distant objects with distinctness. But there are myopic persons who appreciate the delight of seeing well. One of my New York patients, a full-grown woman, after her eyes had been fitted with a pair of concave cylindrics, with which she probably saw clearly at a distance for the first time in her life, told me that after passing down Broadway, she turned and walked up, because, to use her graphic language, "I never had seen the street before, although I was born very near it."

It is probably true that there have been myopic eyes ever since the world began, and yet carefully prepared statistics from many authors, show that it is a disease increased by the occupations of civilized life. Catlin, the Indian traveller, thought that Indians are not often near-sighted.

Myopia is essentially a disease. It depends upon an elongation of the eyeball, from before backward.

Yet this proposition should not be taken too literally. In one sense each departure from a standard type is a morbid condition. Presbyopia is a disease of the muscle of accommodation and of the lens. Hypermetropia is an arrested state of development. In this view gray hairs are a disease, as is short stature, but myopia ranks rather high in the list of departures from the ideal standard, which may, and in a certain number of cases do, result in damage to the sight that cannot be repaired. Thus the eye may become so excessively elongated, that taken in con-

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nection with actual disease about the entrance of the optic nerve into the eyeball, the sight becomes actually lessened.

Then again, a detachment of the retina from the back part of the eye, is more apt to occur in myopia than in emmetropic or hypermetropic eyes. Taking these facts into consideration, myopia may fairly rank as a morbid condition, at least when it is of a high degree. Yet myopic eyes are not so apt to be asthenopic (weak-sighted), as are hypermetropic or astigmatic eyes.

I am here speaking of typical myopia. There is a myopia dependent almost entirely upon an abnormally elongated cornea, and one dependent upon a swelling of the lens, or on "a temporary increase of the refractive index of the aqueous humor" (*Shapringer*, *John Green*), and there is artificial myopia from spasm of the ciliary muscle.

These forms, which may in general terms be called artificial myopia, are actually diseases, and are to be treated as such. The cornea is one of the indices of the general condition. Its flexibility allows it to become unduly curved (conical cornea), and its transparent structure, wholly unsupplied with blood-vessels, makes it very susceptible to disease, either independently, or by extension from the conjunctiva.

CORRECTION OF MYOPIA

The correction of myopia is not as simple a matter as the adjustment of glasses for presbyopia. Yet it is generally possible for a person even of limited experience, to diagnosticate short-sightedness. *If a person cannot see large type, say Snellen C, or LXX, at* 20 *feet, and can still see No. I Jaeger at* 4 *or* 6 *or* 7 *inches, he is almost without exception myopic.* This is, of course, a rude test, but one of value. It is one that may be made in a lonely cabin in the Alleghanies, if an ordinary newspaper can be found. The title of the journal will serve as No. XX or No. XXX Snellen, while the finest type may represent No. I Jaeger. If, however, a person cannot see large type at 20 feet, nor read fine type near the eye, there is something more than myopia. The eye is generally amblyopic from disease, but occasionally such a person is hypermetropic only. If he is hypermetropic, the trial of convex glasses will settle it; if amblyopic, it can only be determined by the ophthalmoscope, or in some cases by examining the eye by means of a convex lens and artificial light (oblique illumination).

Myopia may be, and often is, a congenital condition, or it may be acquired. An eye of the normal length, an *emmetropic* eye, may elongate sufficiently to become myopic. A *hypermetropic* eye, one that is too short from before backward, may elongate, become emmetropic, and pass through emmetropia to myopia. To fully discuss the causes of myopia, does not fall within the province of this little book. It may be said in general terms that it probably depends upon venous congestion in the ciliary region of the eye, a congestion which finally leads to softening and elongation of the tissue. This congestion is favored by general malnutrition of the body with excessive use of the eyes upon fine objects, by insufficient light or in a stooping position. Heredity plays an important part in myopia. A vast proportion of those who consult physicians on account of myopia have one or more myopic ancestors. The English is not as myopic a race as is the German. The reason for this is probably to be found in the habit of life in the open air among the former people, and the great national disposition of the latter to sedentary occupations, and in the employment by them of a peculiarly indistinct character in printing and writing.

Uncorrected myopia diminishes very much the capacity of the individual both for enjoyment and education in the large sense. To condemn a boy or girl to see one-half that his fellows do, is to interfere seriously with the mental, and even the bodily development.

OBLIQUE ILLUMINATION

I think it rather strange that the general practitioner, especially he who makes some claims to practise surgery, does not more often avail himself of oblique examination for making a thorough examination of the cornea and iris. In the detection of foreign bodies upon the cornea, or to determine positively that none is on the cornea or in the conjunctival folds, instances constantly occur where a mistake is made in consequence of not using this means of examination. Small scars on the cornea, if over any part of the undilated or dilated pupil, may very seriously affect the vision and yet be invisible to an ordinary examination. He who attempts to improve defective eyesight with glasses, must be able to positively exclude the cornea from any opacity. This can only be done by using oblique illumination. The means for this are very simple, and they are to be obtained in almost every emergency, if the practitioner will simply always have with him, as a

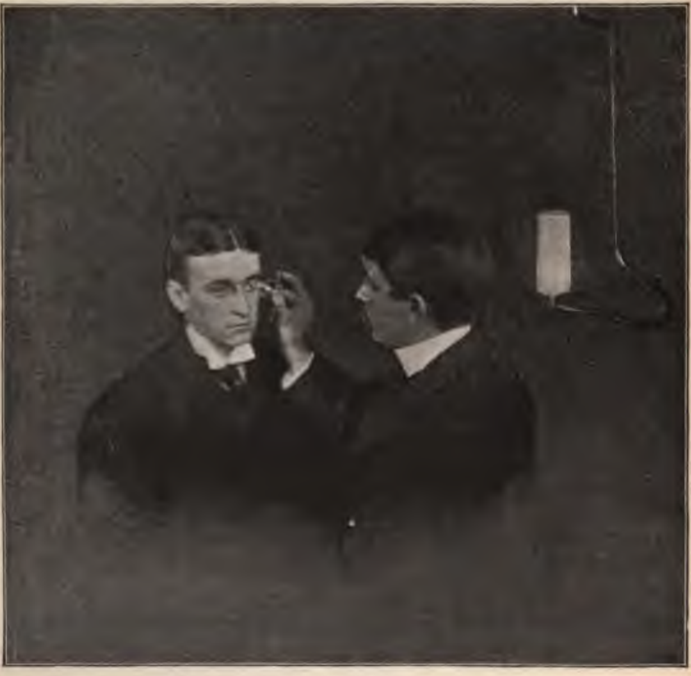

FIG. 9.—OBLIQUE ILLUMINATION
(From a photograph by Dr. Edgar S. Thomson)

part of his surgical outfit, a small magnifying glass of say 12 diopters or 2 inches' focal distance, and get a good light in an otherwise darkened room. He will be able to throw a good illumination from a candle flame, a gas jet, an oil lamp, or an electric lamp, so as to perfectly examine the cornea and iris. He who is not able to examine the eyes with the ophthalmoscope, can often make a diagnosis with the test-types and glasses as follows: The vision of each eye is separately examined with the test-types placed twenty feet away, and the weakest concave glass chosen with which the best vision, at that distance, can be obtained. The vision of myopes for the distance varies with the degree of myopia. A myope who requires a glass of 6 diopters, or 6 inches' focal distance, to cause parallel rays to focus upon his retina, will rarely see more than $\frac{20}{100}$, or perhaps much less, without glasses, while he who requires one not stronger than 1 diopter, or 37 inches' focal distance, will probably have a vision without glasses of $\frac{20}{40}$. Those unfortunates who have a myopia requiring a glass of 18 diopters (2 inches) for its correction, will perhaps see only $\frac{6}{200}$ without glasses, and they may be well contented with

$\frac{20}{100}$ with the myopia properly corrected. Myopia of the latter degree is indeed a misfortune. Such a person is shut off from all distant vision, and literally gropes his way through life.

Presbyopia, as we have seen, is distinguished by the removal of the near-point of vision. In myopia, the far-point is brought near the eye. When the vision has been noted, and we suspect myopia, it is well to begin with *convex* glasses in endeavoring to improve the vision, for there are cases of hypermetropia that appear to be myopia. If we find that convex glasses make the vision worse, we turn to weak concave, and, testing each eye separately, we go on until we find the glass that produces the best result. Often patients are not able to say with which glasses they have best vision, when the difference is not great. *In myopia the rule is to give the weakest glass that gives the best vision.* It is to be remembered, however, that many myopes can never get $\frac{20}{20}$ with any glass. It is not to be expected in high degrees of myopia.

It is to be remembered, however, that the rule does not preclude giving the strongest glass that actually gives the best vision. I have patients wearing glasses of 18 diopters with comfort. On the other hand, some persons, generally those of rather impatient, opinionated temperament, will not tolerate perfect correction. I repeat, it is one of the small mysteries of life that some persons do not desire to see as well, that is, to as great a distance, and as clearly as they might be able to, did they wear proper glasses. There seems to be an impression in certain quarters, that it is in some way harmful to the eye to see very clearly and far, in distant vision, while there is a great horror of too strong glasses. Very few myopes wear too strong glasses.

To over-correct myopia is to convert the myopic eye into one that is hypermetropic, and to add the troubles of asthenopia to those of indistinct vision. To correct simple myopia would always be an easy task, were it not that young myopes are very apt to add a certain degree of artificial myopia to that which is real, and which depends upon an elongation of the antero-posterior diameter of the eyeball.

ARTIFICIAL MYOPIA

Besides this, some young hypermetropes suffer from spasm of the ciliary muscles, and become *artificially myopic.* Young myopes may demand concave glasses that are too strong, unless their accommodation is paralyzed before the tests are made, while hypermetropes will reject convex glasses, which they really should have, and prefer concave, and see better with them; whereas, to give them is to cause all their troubles to increase tenfold. *It is, therefore, not safe to prescribe concave glasses to all young persons simply because they see better with them.* Before doing this in doubtful cases, it is wise to instill a solution of the sulphate of atropia into each eye after each meal, for two or three days. Such a use of belladonna will put the accommodation at rest. If, after this, concave glasses of nearly the same strength as those which were required before the atropia was used, still improve the vision, the patient is undoubtedly myopic, and we need not hesitate to prescribe the glasses that give the best vision. It is always a suspicious circumstance, when a young person suddenly acquires poor vision which is markedly relieved by weak concave glasses. For example, if a young girl cannot read but $\frac{20}{100}$, and with a concave glass of 1 diopter gets vision of $\frac{20}{20}$, we may be pretty sure that she is suffering from spasm of accommodation.

Such patients may be distinguished from true myopes by the fact, that they see better at one moment than another, and that they have great trouble in using their eyes, for the near, which real myopes seldom do. Yet spasm of accommodation is a very rare affection, so that atropia is seldom required for the diagnosis of myopia. The most expert observers with the ophthalmoscope cannot determine with exactness between a low degree of myopia and one of hypermetropia.

For this reason, when we wish to determine positively whether an error of refraction, such as a diopter of corneal astigmatism, is myopic or hypermetropic, we are sometimes obliged to use atropia. It is generally found that such cases are those of a myopic and not hypermetropic character.

Provided glasses are properly chosen, it is well for myopes to wear them pretty constantly. I have observed many intelligent and well-educated short-sighted persons very carefully, and I believe the happiest myopes are those who make their glasses a part of themselves, and wear them constantly in waking hours. There are, of course, exceptions to this rule, but they are not numerous. Here, as in presbyopia, as has been said, there sometimes exists a prejudice against the use of glasses, but it is an unfounded one. Civilized beings should see as well as possible. No harm, and generally much good, will result to any one from a proper correction of an error of refraction or a failure of accommodation.

With all its disadvantages myopia of a low degree, has some advantages over hypermetropia and emmetropia. Its subjects see very fine objects better than by their neighbors, and in middle and advanced life, a myope can often read without glasses, or with those with which they go about.

Of late years, the operation of removal of the crystalline lens, which reduces the refraction to emmetropia, or hypermetropia, has been successfully performed for the relief of cases of excessively high degree of myopia. It is an operation that may properly be advised when the myopia is of such a high degree as to prevent convenient use
e eyes.

ccount of the dangers of myopia, the
s of the State should take every care, by
oper schoolhouses, with sufficient light

and comfortably adapted desks, to prevent the advance of what may easily become in America, as it has already in some of the older countries, a great evil. Here, as in so many other conditions coming under the oculist's care, it is not only a matter of glasses, but also of the maintenance of the nutrition. All the wisdom of a most experienced practitioner will be required. Poorly lighted schoolhouses with poorly printed books, occupied and studied by poorly nourished children, will soon produce a race of myopes; while the opposite conditions will do much to preserve humanity from the widespread increase of short-sightedness.

Myopic children should be examined at least once a year, to determine whether the myopia is increasing. It is perhaps not too much to ask, that all young persons should be examined at least once in their lives, as to the condition of their vision and refraction. All schools should be carefully inspected at fixed periods as to the vision of the children. Cases have been found of very poor sight in scholars who have not been suspected of having trouble with their eyes or defective eyesight, until the inspection occurred.

It is a rule, to which, however, there are exceptions, that myopia advances. If it be of a high degree in early life, and continues to advance in middle age, the most serious consequences to the eyesight may, and often do, result. But if myopia cease to advance in early life, say at twenty-five, it is not likely to progress, and may even recede in old age. For example, I know the case of a gentleman of about seventy-five years of age in whom the myopia has diminished from 6 to 3 diopters in a period of about ten years.

It seems to have been pretty generally believed by our profession that short-sightedness never lessens, although Donders stated that it sometimes did in old age. Carter[1] says "the degree of myopia as measured by the lens which corrects it never diminishes." This is a general rule, but myopia sometimes lessens in degree, not only in old age, but also in youth.

An example of the decrease of myopia in early life is the following:

The first examination was made independently by two competent authorities — Dr. Marmion of

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[1] *l.c.*, p. 100.

Washington and Dr. Emerson of New York. The patient was a young lady of twenty-four years of age when the first examination was made. Her vision was then, 1887, $\frac{20}{20}$ with -2.50 D. In 1893 her vision was $\frac{20}{20}$ with -1.50 D. The last examination was made by Dr. Emerson alone. Thus there has been a decrease of the myopia in this young person of 1 diopter in six years. There is no astigmatism.

Spasm of accommodation can be positively excluded in these cases. It is probable that the change in refractive power has occurred in the cornea in the younger person. A field for exact observation is open in this direction. The ophthalmoscope and ophthalmometer, will enable us to definitely determine the cause of the change from greater to less refractive power. Donders believed that hyperopic eyes never became myopic, but in several cases in children I have watched the advance from hypermetropia to myopia, and so have other observers (Risley) since the time of Donders's writings.

The following case illustrates the lessening of myopia in advanced life. It is best contained in an extract from a letter from the subject.

My Dear Doctor: One of my eyes is much more near-sighted than the other. It used to be very perfect, like a microscope, but the focus was just at the end of my nose. Not practically valuable, therefore, and that has thrown all the labor of my life, and you know I have done some writing and reading,—you will never know how much. So my eyes, or rather eye, went the usual course of near-sightedness, got worse and worse from youth to manhood. I actually got to wearing glasses No. 5½. 6 was as strong as I needed, and my usual wear had been 7. Then I began to find I could not read at all with them. I did not use glasses to read with, never did, but I mean I could not distinguish the largest letters, such as theatre signs, on the street. I supposed my eyes were giving out, but on trying new glasses, found they were getting better, as I could see perfectly with No. 9. Could read small print and see at a distance, better, indeed, than I had seen during my memory at all. No. 9 even seemed rather strong, and I got 10 to wear in ordinary work. Then I gave up 9 altogether, and went from 10 to 11 and now am wearing 12. The change from 9 to 12 was gradual during about four years; the other came without my knowledge, but I had noticed for some time the change in my eyes. My health has not changed in any way.[1]

This gentleman is a highly educated man, who has led a very active literary and political life, who is now about seventy-three years of age.

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[1] This is a change of about 3 diopters during his life.

The following are fair examples of the myopic cases which present themselves for investigation and relief:

Illustrative Cases

Case I. — *A High Degree of Myopia, with Chroiditis and Hyalitis.*

H. J. E., aged 65. This lady has worn glasses for near-sightedness since she was 12 years of age. For the last five years her glasses have been unsatisfactory. With the right eye, by nipping her lids together (blinking), her vision is $\frac{20}{100}$. She reads No. I Jaeger at 2 inches fluently. With the left eye, her vision is $\frac{6}{200}$. This only is reached by blinking. She reads No. I Jaeger with this eye also, but not easily. With the ophthalmoscope it is seen that she has posterior staphyloma in each eye, and that the vitreous is not clear. In the right eye, the ophthalmometer shows that she has no astigmatism. In the left there are 1.25 diopters against the rule. She was ordered a – 20 D for the right eye, and for reading, – 15 D, R and left, –10.

This is extreme myopia, and the myopia has resulted in serious disease of the choroid and vitreous. Good vision, for the distance, is not possible in such a case, although, as is observed, she can read the finest type. Were the patient a young person, the operation for removing of the lens might be properly undertaken.

CASE II. — *The following case illustrates the beginning of myopia, with inflammatory conditions, so that considerable asthenopia results.*

O. A., aged 24, a clerk by occupation. He writes all day; complains of blurring and pain in his eyes. Vision in the right eye is $\frac{20}{70}$, with -1, it becomes $\frac{20}{20}-$. The left eye, $\frac{20}{30}-$, it becomes $\frac{20}{20}$ with -50. The ophthalmometer shows that he has only half a diopter of astigmatism, with the rule. Like so many cases of a low degree of myopia, with the ophthalmoscope the optic nerve entrance seems to be hyperopic. Atropia was ordered, as a therapeutic means only, because the diagnosis of myopia was not questioned. It was also thought to be progressive myopia, resulting from improper conditions of life; that is to say, too much use of the eyes, with bad illumination. The myopia of the right eye was reduced to 25; in the left eye, where before atropia was used, he required one-half a diopter; he declined glasses. He was advised to change his occupation, and not have any glasses for the present. Three months afterward his vision in the right eye was $\frac{20}{40}$. It becomes $\frac{20}{20}+$ with -75. It was $\frac{20}{20}-$ on the left side, and becomes $\frac{20}{20}+$ with -75. He was ordered these glasses. Six months afterward, his eyes are still not free from pain, although he has not used them so closely, and the myopia hanged.

INCIPIENT CATARACT

Many cases for which glasses will do very little come to the oculist under the impression that properly chosen lenses will afford entire relief. Especially is this true of incipient cataract. Oblique illumination and the ophthalmoscope will show why glasses will be only of partial service. The beginner must be on his guard against prescribing glasses, with a hope of perfect relief, when changes in the lens exist.

CASE III. — Mrs. T. C. B., aged 60, has been myopic all her life. Of late her sight is not so sharp. It is found that her vision in the right eye is $\frac{6}{200}$, without glasses, with – 4.50, $\frac{20}{70}$. The left, $\frac{15}{200}$, with – 4 D, $\frac{20}{100}$. There are opacities of each lens, and the vitreous is not clear. Still, she is advised to wear her glasses, because they greatly improve the vision.

The following case is one of *myopia, uncomplicated by any morbid conditions.*

CASE IV. — B. M. G., aged 21, a bank clerk. Says he is near-sighted. He has about $\frac{12}{200}$ vision with each eye, without glasses. With – 2.50 D he has $\frac{20}{20}$. The ophthalmometer shows 50 D with the rule. He is accordingly ordered – 2.50 D for all purposes.

G. K. H., aged 37. Says he has been near-sighted all his life. Has used glasses since he was eighteen. Is wearing a – 3 with a prism, base in, for near work, and – 4 for distance. His vision improves from $\frac{8}{200}$ to $\frac{20}{30}$ in the right eye with a – 5.50, and the left exactly the same. He reads No. I Jaeger, at 8 inches with a –4. He is advised to wear –5 for all purposes, or, if he prefers, –4 for reading, and to give up prisms.

CASE V. — G. J., aged 30, a deaf-mute. At six years of age lost his hearing from cerebro-spinal meningitis. His vision improves from $\frac{15}{200}$ in each eye without glasses, to $\frac{20}{20}$ – in each eye with a – 2.25. The ophthalmometer shows that he has over half a diopter, – 0.75 diopter of astigmatism, with the rule. He is therefore ordered – 2.25.

CHAPTER IV

HYPERMETROPIA

The discovery of hypermetropia led to change in ophthalmic practice. — Definition. — A flat eye. — Professor Dewey of Union College. — Varieties of hypermetropia. — Glasses not required for the distance in hypermetropia, unless they improve vision. — Cases.

It was the discovery of the widely spread existence of hypermetropia and of hyperopic and myopic astigmatism, that actually created a new and very large field for practice in the affections of the eye. The world was ready for these discoveries. Mental activity was made possible for many who, until glasses were invented for them, were shut off from participations in affairs involving the use of the eyes upon near and fine objects, almost as if they had no eyesight.

All the civilized races were found to have a very large proportion of people, who were better for using glasses. One marked evidence of this revolution, may be seen by comparing the number of opticians' shops to be seen a quarter of a century ago in cities and towns, with those now to be seen in any populated thoroughfare. Then also, if one were to note the number of persons whom one meets in the streets wearing glasses, it will be seen that they have increased marvellously in a generation. It is not to be denied, that in quite a proportion of cases glasses are unnecessarily, and even improperly, worn. But this is relatively a small number, with complete allowance for what may be even termed a craze in the use of spectacles. In low degrees of hypermetropia and astigmatism, when vision for distant objects is thoroughly good, glasses are sometimes improperly prescribed, but while this is true, the fact remains, that the human race has been and is immeasurably benefited by the wide promulgation of the proper rules for the improving of eyesight by glasses. Many a life that would have been nearly useless, without glasses, has been made useful simply by wearing them. This is especially true of cases of hypermetropia and hypermetropic astigmatism.

DEFINITION OF A HYPERMETROPIC EYE

A hypermetropic eye is one that is too short from before backward. This abnormity usually depends upon shortness of the whole globe, but in exceptional cases it may depend upon changes in the lens or vitreous humor, which have no effect upon the length of the eyeball itself. Excluding the myopic, most of mankind are hypermetropic, but the hypermetropia is either grown out of, or it is not of a degree requiring correction. The fact that many children require convex glasses as urgently as their presbyopic parents or grandparents, has led to the prescription of glasses by the physician instead of the optician. When, by means of the ophthalmoscope, the eye could be accurately examined in its interior, and its refractive power measured, the fact that there were thousands of young persons in the world, who were unable to have a full use of their eyes, until their sight was made good with glasses, soon became manifest. Before this, all young persons who were unable to use their eyes for any length of time without pain or fatigue, were supposed to have serious disease of the optic nerve or retina, and were rigorously excluded from all reading or the like. If, as some of them did, they found relief from convex glasses, they did it without medical advice, and wore them at their peril. Here and there it was known among scientific men that there were "flat eyes" among young people, and that they could be benefited by correcting the insufficient refraction, but this knowledge was in the highest degree exceptional, and gained no general circulation. Professor Dewey, of Union College, in New York, even wrote a paper on the subject, but it attracted very little attention. This was, perhaps, due to the fact that it was published in *Silliman's Journal*, which was not extensively read by physicians. Yet, as I have intimated, it was not until the ophthalmoscope was invented that these cases could be accurately and positively diagnosticated. To the invention of Helmholtz, and the studies of Donders, we are indebted for the practical benefit that tens of thousands of people, that formerly had no relief for their imperfect or weak sight, receive from the use of convex glasses.

Hypermetropia or hyperopia is divided into several varieties.

CLASSIFICATION OF HYPERMETROPIA

1. *Manifest Hypermetropia.*—In this form the vision is at once improved by convex glasses. If

the patient be placed 20 feet away from the test-letters, it will be found that his vision is defective. Let us say, for example, that he is only able to see letters, that should be seen at 70 feet, 20 feet away, $V = \frac{20}{70}$, a weak convex glass, say of 1 diopter, is applied, and the vision raised to $\frac{20}{30}$, and finally one of 1.50 diopters brings it up to $\frac{20}{20}$. The degree of hypermetropia is measured by the strongest glass that gives the patient $\frac{20}{20}$.

If no convex glass will bring the vision up to $\frac{20}{20}$, and especially if the patient miscall certain letters while he insists that he sees them correctly, we may suspect that not only is the eyeball too short, but that the cornea is shorter in one meridian than the other, *hypermetropic astigmatism*, or that it is too long in one meridian, *myopic astigmatism.* To correct such a defect as this we require a glass that does not refract light in all of its meridians. This is to be found in a glass ground, not from a sphere, but from a cylinder. As is well known, concave and convex glasses are ground from a sphere, and are called spherical glasses.

THE OPHTHALMOMETER

At this point the ophthalmometer become very important aid in diagnosis. The gene practitioner will, of course, not be expected be able to use this instrument; but no one w claims to be able to properly correct any refr tive error that may occur in practice, can w go on without using it. Without it, he is forc in a large number of cases to use a local age atropia in some of its forms, or homatropi or scopolamine, in order to paralyze the acco modation, which otherwise, *in young perso* will prevent him from accurately fitting t eye with glasses. If, however, the examiner h no ophthalmometer, in adults, he will usual be able to accurately diagnosticate astigmatis with the test-letters and cylindrical glasses. formerly supposed that in cases of manifest h permetropia, when the vision is nearly broug up to the normal standard with spherical glass that it was of no especial advantage to measu the corneal astigmatism. Ten years' experien in measuring the cornea, has proved to me th is of great importance to know of the existen or absence of corneal astigmatism. Corneal astigmatism of 1 or even 1.50 diopters is readily concealed by a young person so that only a mydriatic will reveal it, and yet vision be satisfactory, with spherical glasses only. It is in just this large class of cases of hyperopic astigmatism, with or against the rule, that the ophthalmometer has proven of signal benefit.

As will be shown in discussing astigmatism, it is much better for the relief of asthenopia to correct any existing corneal astigmatism of more than three-quarters of a diopter, than to correct a low degree of hypermetropia.

When an examination leads us to suspect the presence of astigmatism, cylindrical glasses are taken, beginning with the weak. numbers, and while the patient has before his eye in an appropriate frame the convex glass with which he sees best, the cylindric is added and its axis rotated until we hit upon that one which brings the vision up to $\frac{20}{20}$ with no miscalling of the various letters. Many distinguished oculists make use of tests containing radiate lines like the dial of a clock (the wheel test), but I regard them as unnecessary if the method of testing be carried out as has just been indicated, and I have long since discarded all tests but letters.

A moment's consideration will show that the vertical, oblique, and horizontal lines necessary for testing for astigmatism, are all to be found in Snellen's letters or in any of the text types.

2. *Latent Hypermetropia.* — Manifest hypermetropia and manifest hypermetropic astigmatism are not always found, however, in those who really are hyperopic and astigmatic. In some young persons the defect is concealed by spasm of the ciliary muscle, and vision may be $\frac{20}{20}$ without glasses, or it may be $\frac{20}{40}$ and no improvement be effected by the use of any glasses, and yet an error of refraction causing much distress in using the eyes may exist. This is *latent or concealed hypermetropia.*

As has been already observed, this real condition of things may simulate myopia. The use of the sulphate of atropia, in a four-grain solution, in each eye for three days, will usually reveal latent hypermetropia if it exist. The effect of atropine and other agents which act upon the accommodation in an *ideal and emmetropic eye,* is simply to prevent the subject from accommodating for near objects. In such an eye, vision at a distance remains unchanged. If it was $\frac{20}{20}$ before, it will remain so after the ciliary muscle has ceased to act. An emmetropic eye does exist, although rarely, as I showed in 1878.[1] Most eyes that are not myopic, when under the full influence of atropia, are improved in distant vision by a weak convex glass, say one from $\frac{1}{60}$ to $\frac{1}{42}$, D. 0.50° to D. 0.75°. As I have said, most of mankind are hypermetropic. These slight degrees are not necessarily any cause for weakness or impairment of vision. It has sometimes been hastily concluded that a cause is found for asthenopia, headaches, nervous diseases, and so forth, because a low degree of hypermetropia or hypermetropic astigmatism is discovered. Now, it is true that the correction of a low degree of latent hypermetropia, and more especially of hypermetropic astigmatism, may sometimes relieve asthenopia and headaches; yet as a rule it is only when the hypermetropia is of a degree requiring a glass of one diopter for its full correction, that any great benefit is realized from the use of convex glasses. There are, however, in every oculist's note-book, as there were in the published cases of Donders, who first fully utilized spherical and cylindric glasses — convex and concave — many wonderful cases of great relief from serious nervous symptoms simply by the use of correcting glasses. There may be spasmodic action of the ciliary muscle, which sometimes produces a train of symptoms that no drug will reach, but which are relieved by the proper adjustment of spectacles.

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[1] Transactions of the American Ophthalmological Society, 1878.

In persons less than forty years of age, the test by glasses is very unreliable. The ciliary muscle and the internal recti are so active, that it is generally impossible to be sure that the astigmatism is correctly estimated without the use of a mydriatic. Hence he who does not use the instrument to measure the radius of curvature of the cornea, must here paralyze the accommodation. After this has been accomplished the results are certain. In ordering glasses by this method, while the total astigmatism, thus indicated, may be corrected, it will be very unsafe to correct the total hypermetropia. Indeed, as has been indicated, a low degree of hypermetropia, say from 1 to even 2 diopters, will scarcely ever need correction *if there be at the same time* a considerable degree of astigmatism; that is to say, from 1 diopter up. In persons under forty years of age, it is generally sufficient to correct only the astigmatism, if the vision be $\frac{20}{20}$ without glasses.

Patients having latent hypermetropia, who have very good vision for the distance when not under the influence of atropia—vision say of $\frac{20}{30}$ or $\frac{20}{20}$—should only wear glasses for close work—reading, sewing, and the like. They will not appreciate the difference between $\frac{20}{30}$ and $\frac{20}{20}$ or even between $\frac{20}{40}$ and $\frac{20}{20}$, as any emmetropic person may convince himself by adjusting concave glasses upon his own eyes, making himself hypermetropic, say 1 diopter. If he will then note the difference in his visual power with or without the artificial hypermetropia, he will find for ordinary vision that it is not great.

This view is not everywhere accepted, in this country at least; but that it is correct I am more and more convinced as my experience is enlarged. It is true that there are patients with facultative hypermetropia,—that is, those who see equally well with or without convex glasses,—who prefer to wear them all the time. Such persons should be allowed to do so, but to those to whom they are no comfort, but an annoyance, they will be of no benefit and they should not be advised to wear them. The theory of the conversion of a moderately hyperopic eye, with good vision for the distance without glasses, into an emmetropic one with a view to diminishing asthenopia or relieving headaches, is an illusory one. I have had great satisfaction in relieving patients who had $\frac{20}{20}$ without glasses, but who were advised to wear them all the time, from a real thraldom, and I have found that their asthenopic symptoms were relieved just as effectually when they wore these glasses for near work only. It is only exceptionally that such persons should be required to wear glasses constantly, and then they will be agreeable to them. The emmetropic eye is an ideal eye. The one that is moderately hyperopic is the one which has been generally given the human race — to the civilized certainly, and probably to the barbarous also.

3. *Facultative or voluntary hypermetropia.* — There is a class of patients who see at a distance equally well with or without convex glasses. They will see $\frac{20}{20}$ with no glass or with a convex

one. Such persons are hypermetropic, for no emmetrope can wear even very weak (0.25 D) convex glasses without being conscious of some blurring of the vision, when he looks at the test-types placed twenty feet away. This variety of hypermetropia may, like the latent and manifest,

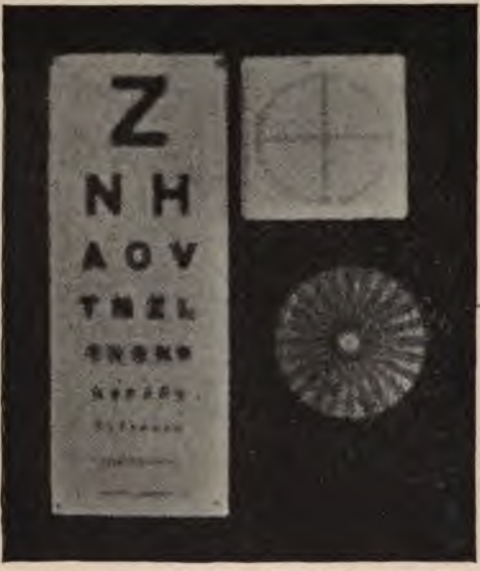

FIG. 10.—REFRACTIVE ERROR + 0.50 D. G. J. BULL

This plate represents an error equal to + 0.50 D. The blurring is marked, while the smaller letters have almost completely faded away. In the so-called "clock dial test" there is a stellar appearance around the centre.[1]

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[1] Transactions of the Ophthalmological Society of the United Kingdom, 1896.

cause asthenopia. It is not, however, usually necessary to place the eyes under the influence of atropia to correct it, but the highest glass with which the best vision is obtained will be the proper glass for close work.

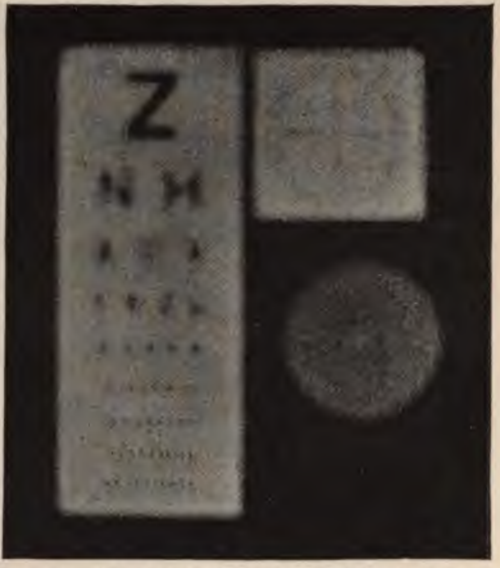

FIG. 11. — REFRACTIVE ERROR + 0.75 D. G. J. BULL

In an error represented by + 0.75 D, as in this figure, the blurring is very great; only the Z is very clearly seen, and this has lost much of its blackness. The clock dial is effaced, and only a ground-glass appearance remains.

Figures 10 and 11 illustrate the effects of refractive error upon the vision. They are taken from Dr. G. J. Bull's paper on the visual effect of refractive error.[1] Dr. Bull, by attaching spherical and cylindric lenses to the photographic camera and then taking views of Snellen's test-types, secured the appearances of the letters as seen by patients with refractive error. His paper will repay careful reading. The reader has already been advised to make himself hypermetropic and myopic by the use of correcting lenses, and thus see for himself how an uncorrected error of refraction causes its subject to see. These plates serve the same purpose in a simpler way.

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[1] Transactions of the Ophthalmological Society of the United Kingdom, 1896.

CHAPTER V

CORNEAL ASTIGMATISM

Plays an important part in the production of defective and weak vision.— Astigmatism *with the rule and against the rule.*— More productive of asthenopia than hypermetropia.— Polyopia monocularis.— Latent astigmatism.— So-called binocular double vision.— Rules for using atropia to paralyze accommodation.— Method of testing with glasses.— Ophthalmometry.— Rules for using the ophthalmometer.— Images in errors of refraction.

As has been already intimated in the description of hypermetropia, astigmatism plays a very important part in the production of defective and weak vision. This is true especially when it is of high degree, say from two diopters *with the rule*, or from one-half a diopter *against the rule.* But the presence of one diopter with the rule, or of a quarter of a diopter against the rule, may, and often does, especially if associated with hypermetropia of more than one diopter, produce very troublesome asthenopia. I am now speaking of corneal astigmatism. That form dependent upon changes in the lens is not very much in question, and, except in beginning cataract, plays an obscure and insignificant part in practical ophthalmology. We cannot measure lenticular astigmatism except by subjective tests, or very intricate objective tests, and it is very rarely that we are called upon to correct it. But corneal astigmatism is more productive of asthenopia than even hyperopia itself. Corneal astigmatism is the condition in which the refraction is different in the different meridians of the cornea. This difference is usually between the vertical and horizontal meridians, but it may be between any of these. This is regular astigmatism. When it differs in one and the same meridian it is called irregular. Although something will be said of the correction of irregular astigmatism, it is with regular astigmatism that we are chiefly concerned.

The history of the discovery of astigmatism is most interesting, but for that I must refer my readers to the treatises on the eye. Donders, in his definition, confined irregular astigmatism to that produced in one and the same meridian by changes in the lens, when it causes double or multiple vision in one eye, *polyopia monocularis;* but in our day, we speak of irregular astigmatism as that form caused by changes in the cornea, while the term lenticular astigmatism defines the form produced by changes in the structure of the lens In order to appreciate uncorrected astigmatism the emmetrope may make himself astigmatic by holding a cylindric lens before his eye. The axis of the cylindrical glass should be placed horizontally if the lens be convex, and vertically if it be concave. The observer then has in his eye the shortest focal distance in the vertical meridian just as astigmatics generally do. This is cornea astigmatism with the rule. It is against the rule when the opposite condition obtains.

In case the practitioner does not possess and use an ophthalmometer, he will have no recourse in cases of suspected astigmatism, just as in laten hypermetropia, but to use a drug in the eye, with which to paralyze the accommodation while the tests for glasses are being made. But I reiterate my advice to every practitioner to learn to use the ophthalmometer, and make his diagnoses with that instrument, if this be at all possible. If he will do this, he will scarcely ever find it necessary to paralyze the accommodation for the purpose o prescribing glasses. If the existence or absence of corneal astigmatism be once determined, as it may be in a few instants by the use of this instrument, the rest of the work is very simple.

In astigmatism, with the rule, in young persons, even if a considerable degree of hypermetropia coexist, as it almost always does, it is sufficient to allow one-half a diopter to be corrected by the action of the crystalline lens in accommodation, and to correct the remainder by a glass. This glass is usually the one the patient prefers, but be this so or not, we may save ourselves much wearisome subjective work by prescribing the glass for reading, and so forth, which the ophthalmometer indicates. It will be the proper one. If the patient be older, that is, in middle life, or more, it will be necessary to prescribe a spherical glass also to correct the manifest hypermetropia, especially if this be necessary to bring the sight up to $\frac{20}{20}$.

In very young or foolish persons who cannot or will not keep the head still during an ophthalmometric examination, it may occasionally be necessary to use atropia, or homatropine, or scopolamine, in order to approximate the correct glass. When a patient has one diopter of astigmatism with the rule, and vision is $\frac{20}{30}$ or $\frac{20}{20}-$, and that patient rejects positive glasses, but prefer negative ones, there may be a doubt whether w are dealing with myopic or hypermetropic astigmatism. It may possibly be a case of spasm o accommodation, but this is usually not the case Such a patient is generally myopic. Spasm o accommodation usually has an entirely differen set of symptoms. The patient with spasm generally sees badly, say not more than $\frac{20}{40}$, or even $\frac{20}{70}$ sometimes one, sometimes the other, and the visio is brought up at once to $\frac{20}{20}$ with a weak concav glass. This is a very rare, but a marked symptom When it is suspected, a mydriatic must be used and if it be found that the myopia is spasmodic the use of the drug should be continued until convex and not concave glasses can be worn.

Mixed astigmatism, when one meridian is myopic, and the other hypermetropic, which is foun in a very small proportion of cases, may als require the use of atropia, but even here a littl practice, after finding the total astigmatism, wi enable one to properly divide up the positive an negative correction, that is to say, how strong concave and how strong a convex cylinder mus be used in combination.

SIMPLE MYOPIC ASTIGMATISM

Donders, who was no believer in the frequent occurrence of an emmetropic eye, did not think there were many cases when even one meridian was emmetropic while the other was myopic.

Yet it is certain that there are numerous cases when either hypermetropia of a very low degree or emmetropia, coexists with myopic astigmatism. For this concave cylinders are prescribed with great comfort to the patient, and great improvement to the sight. The same holds good with astigmatism against the rule (indirect astigmatism), although in a much less proportion.

Astigmatism, especially astigmatism against the rule, very often produces binocular double vision, which is completely relieved by cylindric glasses without prisms and without operation. Indeed, unless deformity, *strabismus*, result from weakness of the external ocular muscles, cylindric and spherical glasses are always sufficient to overcome diplopia. But of this, more will be said in discussing asthenopia.

A very interesting point in the history of astigmatism, is found in the fact, that a certain

Colonel Goulier, then professor of topography at the Military School of Metz, noticed the frequency of this defect in soldiers at about the time of Donders's work, and without knowing of this. He caused cylindric glasses to be made for quite a number of persons, and sent his observations in a sealed letter to the Academy of Sciences the 12th of July, 1852. This, as will be seen, was about the time of the Dutch investigations of the subject. A fac-simile is here given of a figure which he used for the detection of astigmatism.

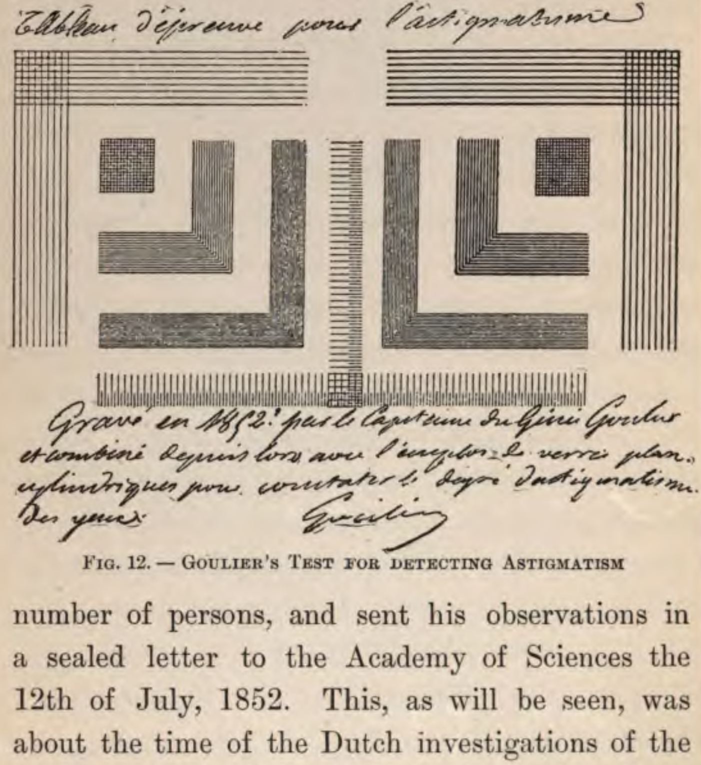

Tableau d'épreuve pour l'astigmatisme

Gravé en 1852: par le Capitaine du Génie Goulier et combiné depuis lors avec l'emploi de verres plan-cylindriques pour constater le degré d'astigmatisme des yeux.

Goulier

FIG. 12. — GOULIER'S TEST FOR DETECTING ASTIGMATISM

Dr. G. J. Bull, from whose *Manual on Spectacles*[1] this cut is taken, remarks that its value is increased by the addition of certain lines written by Colonel Goulier upon one of the test-cards, which was placed in the hands of Javal after 1866.

THE METHOD OF USING ATROPIA

When atropia must be used to paralyze the ciliary muscle, the following rules should be borne in mind. Atropia very rarely produces constitutional symptoms when dropped into the conjunctival sac, but it sometimes does.

1. The solution should be dropped in the outer part of the conjunctival sac, and not in the inner, lest it get into the mouth through the canaliculi and the nasal duct.

2. The solution should only be used soon after eating, not after a long abstinence from food.

3. Only one or two drops should be used for each application.

Unless the physician is very precise in his instructions to his patients in regard to the use of a solution of atropia in the eye, they will not use it with sufficient thoroughness, or as directed.

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[1] *Lunettes et Pince-Nez.* G. Masson, Paris.

For example, they often become alarmed in regard to the loss of sight which its use causes, and they decline to continue it after the first instillation; and they often also omit to put it in the eye on the day of their return to have the glasses fitted. To put ordinary eyes at rest, a four-grain solution should be used once after each of seven regular meals; that is to say, for two days and a half, and very often for a longer period. It is a very troublesome and trying means of getting proper glasses, but a certain one.

When the ciliary muscle is completely at rest, so that fine print cannot be read unless with a convex glass, say of six diopters, an exact conclusion can be obtained as to the refraction by the use of the test glasses. Each eye should be separately tested.

One may begin with weak convex sphericals and work up to the strongest with which the best distant vision can be secured, or begin with strong ones and work down to the low numbers.

After getting the best vision possible with spherical glasses, cylinders may be added, finding the proper axis by turning the glass slowly in the frame until the point of blackish most distinct vision of the test letters in the line being used for testing is found. If the refraction is found to be not very far from normal, it will soon be learned that cylindric glasses alone, will bring the vision up to $\frac{20}{20}$, while only a weak spherical, say of one diopter, is tolerated over the cylinder. If myopia really exist, the vision is not made worse by the mydriatic, and a concave glass before a healthy eye, will bring the vision up to $\frac{20}{20}$ or even to $\frac{20}{15}$.

OPHTHALMOMETRY

Donders calls the ophthalmometer one of the "great treasures for which we are indebted to the genius of Helmholtz." The heliometer, which enables astronomers to accurately determine minute dimensions of the planets in constant motion, according to Donders,[1] suggested the ophthalmometer to Helmholtz.[2]

The invention of a practical ophthalmometer has entirely changed the method of examination for astigmatism by those who have learned to use the instrument. I formerly used atropine in al doubtful cases, in order to determine the refraction, and I was among the very first to urge thi upon ophthalmologists.[1] The chief reason fo doing this was to discover whether or not astigmatism existed, because in young persons it i impossible, and in middle-aged or old persons i is difficult, to positively determine the existenc or non-existence of a moderate degree of cornea astigmatism by subjective tests. But with th ophthalmometer, no mistake can be made by an person who has learned to use the instrumen accurately, if the instrument be a true one, an more than a mariner who has a clear sky, an who knows how to use the sextant, can fail t tell where he is situated on the ocean. The op thalmometer measures and registers the radi of curvature of the cornea. The difference b tween the horizontal and vertical meridians, between any two meridians, can be determin by its use in an instant.

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[1] *Accommodation and Refraction of the Eye*, p. 18.

[2] Helmholtz published his first description of the Ophthalmometer, in Graefe's *Archives*, Band I, Abtheilung II, p. 1.

The following rules for the use of the ophth mometer are drawn from the teachings of Ja and his pupils, the papers of Dr. A. E. Davis, a my own experience. But I believe personal instruction is indispensable for successful use of the instrument. Very little of this is necessary,

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[1] Transactions International Ophthalmological Congress, 187

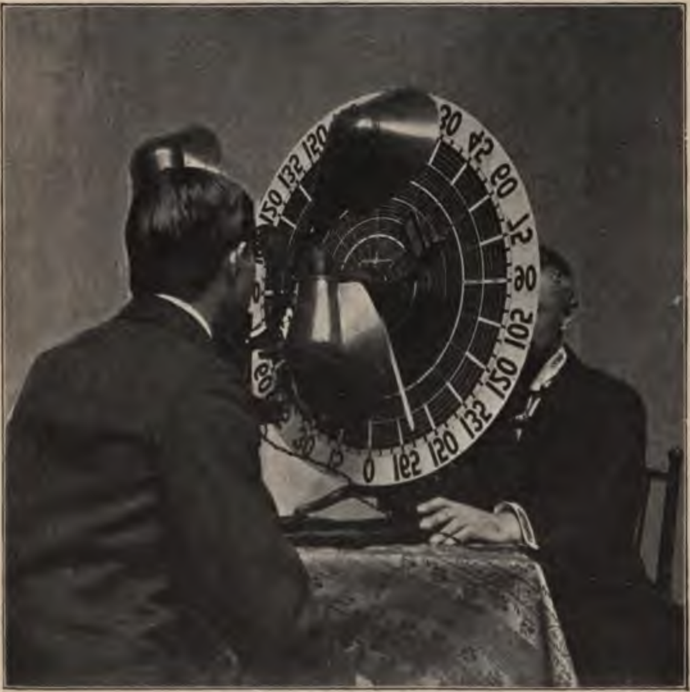

FIG. 13.—THE OPHTHALMOMETER IN USE
(From a photograph by W. T. Georgen)

for a good observer, in a very few lessons, will become sufficiently proficient to go on by himself. But many of the incorrect opinions, as to the value of the ophthalmometer, depend upon the want of knowledge of the writers of the manner of using it.

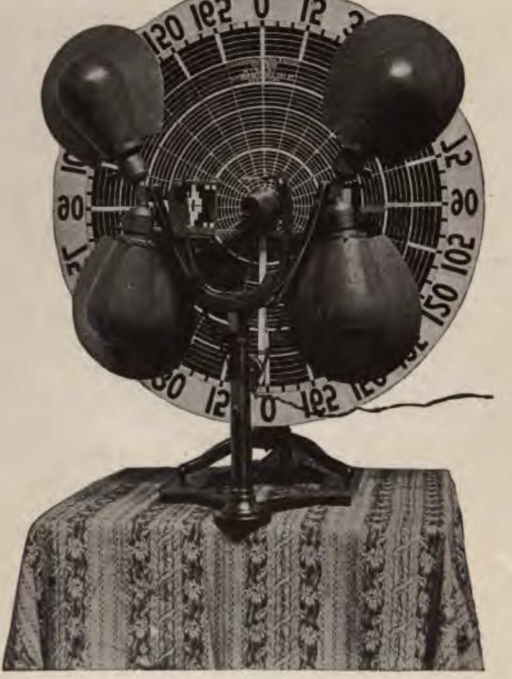

FIG. 14.—THE ELECTRIC LAMPS
(From a photograph by W. T. Georgen)

1. The light. A large window opening on a stretch of fifty feet, and upon the sky, will do very well. A north window is to be preferred.

On all clear, or moderately clear days, this is sufficient. But the best illumination is by means of electric lamps, which are now supplied by all

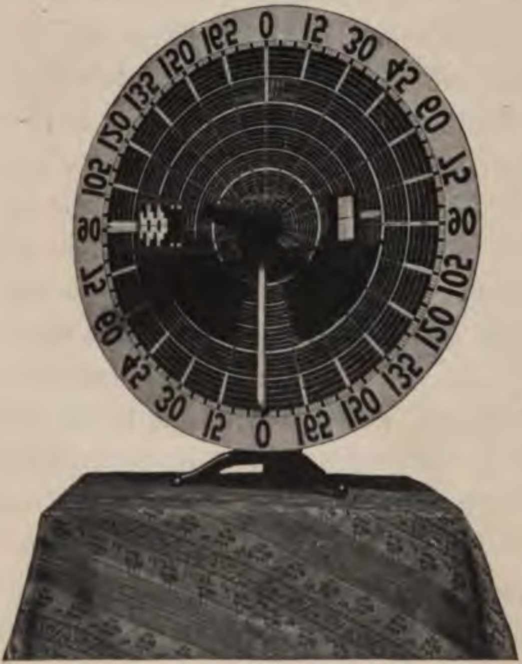

Fig. 15.—The Dial, Tube, Pointer, and Mires
(From a photograph by W. T. Georgen)

makers. If these are not available, gas, with a Welsbach light, is very good.

2. The telescope or tube of the instrument is correctly adjusted by turning it until the cross-

hairs, which are in the tube, are brought in distinct view. This is done by turning the ocular or eye-piece to the right, when the observer is myopic, and to the left, when he is hyperopic. The farther to the left the eye-piece can be turned, and the cross-hairs be still maintained in clear view, the better. Dirt in the tube is shown by irregularities in the calibre of the cross-hairs.

3. Place the patient at the instrument with his chin on the chin-rest and his forehead firmly against the forehead-rest, with his eyes wide open and upon a level.[1] To know when the eyes are exactly horizontal, which is all-important, one should sight through the *transverse* slit in the disk just above the tube or telescope of the ophthalmometer. This point cannot be insisted upon too much, for the least rotation of the head will throw the axis off 5° or 10° from what it really is, and then the tests of the axes by means of the glasses of the trial case, do not correspond with the finding of the instrument, and the ophthalmometer is blamed when the examiner is at fault.

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[1] That the head should be firmly placed against the forehead-rest, is of vital importance. A little movement here will prevent an exact observation.

4. The eyes being on the same plane, the little shade is placed in front of one eye. The focus is got with the other. To focus the eye, sight along the upper side of the tube through the notch (something like a gun-sight) at the centre of the cornea. Then sight through the tube, at the same time moving the instrument up and down by means of the screw, until the image of the disk, doubled by the prism in the telescope, and the reflection inverted from the cornea, comes into view. Pay no attention to the two images far out at the sides, but fix the gaze upon the two in the oval space.

5. Get the "primary position." The primary position is that point at which the transverse lines, dividing the mires into halves, become exactly coincident so as to form one continuous straight line. This is simply an indication (when there is any astigmatism) that we have found one of the axes of the astigmatism. The other axis, in the great majority of cases, is 90° from this. It is, therefore, at right angles to it, and is the secondary position. When there is no astigmatism, the transverse lines are always opposite and coincident. When there is irregular astigmatism they

are never coincident, and cannot be made so. To obtain the primary position, first turn the long indicator to 0°. If the transverse lines are coincident at this point, go no farther; the primary position is obtained. If not coincident at the zero point, turn the tube from right to left, and go on very slowly, until the two lines exactly coincide, if this occurs by the time 135° is reached. If the transverse lines do not become coincident before or when 135° is reached, go no farther in that direction, but turn back to 0°, now turning the tube from left to right toward 45°. The lines will necessarily become coincident before 45° is reached. The primary position is never farther than 45° on either side of 0°. If we turn the tube farther than the 135° mark on one side, or the 45° mark on the other, the instrument will read astigmatism "with the rule" when it is really "against the rule," and *vice versa.* When the lines become coincident at 135° or 45° — the extreme limits, being just halfway between 0° and 90° on either side — by preference 135° is taken as the primary position. This for the sake of nomenclature. We see, then, that the primary

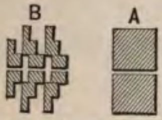

FIG. 16. — MIRES

position may be at 0°, or any point within 45° of that point, but *never* beyond. Having made the cross-lines of the mires coincident, it is only necessary to approximate the mires exactly to be ready for the next step.

6. Obtain the "secondary position." This is secured by turning the long indicator 90° from the primary position to the left. If the mires overlap, there is astigmatism with the rule, and the number of steps of overlapping is the degree in diopters of astigmatism. If it overlaps two steps, it should be written thus: "Astigmatism with the rule, 2 D 90° + or 180° –." If the reflectors separate when the second position is reached, it indicates astigmatism against the rule. Before moving the indicator from the second position, approximate the mires again, and then turn back to the primary position, when the mires will overlap — say one-half or one or two steps. The result is written thus: "Astigmatism against the

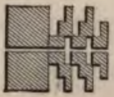

FIG. 17. — MIRES EXACTLY IN APPOSITION

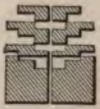

FIG. 18. — MIRES MEASURING ONE DIOPTER WITH THE RULE

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rule, 180° + or 90° –." Following the rules above, the long index always indicates the axis of the convex glass to be worn, and the short index on the reflectors the axis of the concave glass that is needed — *in any case.* The tube is always turned from the right to the left, simply that we may conveniently get at the mire which is to be moved.

The observer should accustom himself, as in using the microscope and ophthalmoscope, to keep both eyes open during the examination. It is convenient and exact to note the result in writing as soon as one eye is examined. The relaxation of the accommodation is important in making observations with the ophthalmometer.

The instrument as finally perfected — so-called model of 1889 — consists of:

1. A telescope supported by an upright, mounted upon a tripod.
2. A large, graduated steel disk or dial attached to the telescope.
3. A graduated arc.
4. Two mires designated "the steps" and the "parallelogram," which are both attached to the arc.

5. A solid metal brass-finished base, with a support for the head by means of an adjustable chin-rest.

6. Gas or electric light apparatus attached to the head-rest for illumination.

The telescope and disk rest on a tripod, as seen in the picture, preferably made of metal. The head-rest is also shown in the picture, and the means of illumination by electric light. The mires are sometimes called targets (*mire*, French for target). It is the overlapping of these mires on the second turning, as described in the directions for using the instrument, which determines the degree of astigmatism with the rule. The separation of these mires on the second turning indicates astigmatism against the rule, and the overlapping on the third turning of 90° would show the degree of astigmatism against the rule. If no astigmatism at all exist, there is no overlapping and no separation on the second turning.

A recent alteration is a thumb-screw, fixed on the graduated arc. By means of this screw, *both* of the mires are made to move at the same time, and to an equal extent, one not remaining fixed on the arc at 20° from its centre, as before, whi the other was left to do all the moving.

Those who are interested in the study of tl optical system of the ophthalmometer,[1] will find complete account in my treatise on the Eye.[2] Oı

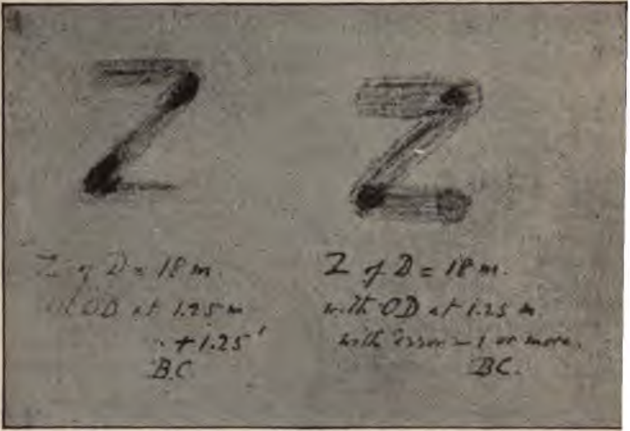

FIG. 19.—HYPEROPIC IMAGES OF THE LETTER Z. G. J. BULL

may learn to use the ophthalmometer skilful without understanding thoroughly the optical pr ciples on which it depends, and yet, scarcely a practitioner would be willing to leave the subj in this way.

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[1] Dr. A. E. Davis is about to publish a manual of ophthalm etry entitled *The Ophthalmometer, Its Clinical Use.*

[2] *Diseases of the Eye*, Wm. Wood & Co., New York, 1894, p. 1

IMAGES IN ERRORS OF REFRACTION

Those whose sight has been always defective cannot compare their vision with that of normal eyes until the error is corrected by glasses. Many of them think that the whole world sees as they do, until properly chosen glasses are given them. Those who acquire defective vision, for example, patients with progressive myopia, cataract, or retinal disease, give very accurate accounts of the deviation from the normal.

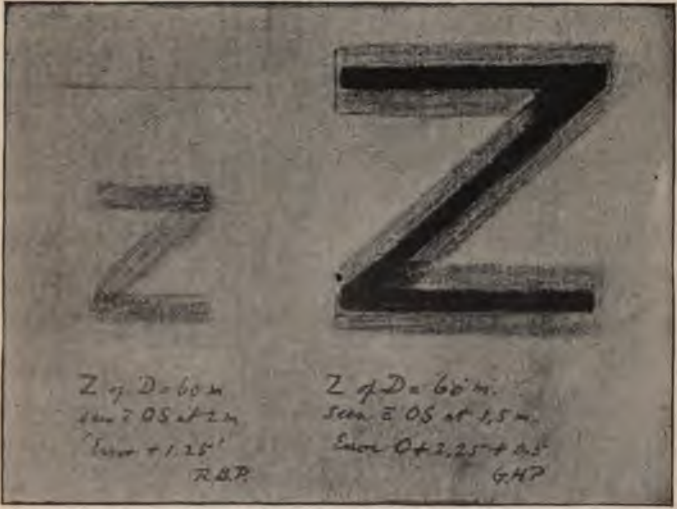
Z of D = 60 m
Seen c̄ OS at 2 m
"Error + 1.25"
R.B.P.
Z of D = 60 m.
Seen c̄ OS at 1,5 m.
Error 0 + 2,25 + 0.5
G.H.P.

FIG. 20.—ASTIGMATIC IMAGES OF THE LETTER Z. G. J. BULL

By procuring images of letters as seen b hyperopic and astigmatic patients, and as draw by them, Dr. Bull gave a very graphic picture c how such subjects see, and he also proved that th images are identical with those produced by th photographic camera and shown in his pape which have been reproduced upon various pag of this book. The cuts here given illustrate th point. They all clearly show the peculiar dar spot in the angles of the letter, which is a chara teristic of the photographic plates.

CHAPTER VI

ASTHENOPIA

Prisms formerly generally prescribed. — The real cause of much of the double vision supposed to result from the want of equilibrium of muscles of the eyes. — Dr. G. J. Bull on this subject. — Tests for want of equilibrium of ocular muscles. — Their unimportance. — The relation of constitutional diseases to the eyes. — Cure of headache, vertigo, by correcting glasses. — Donders upon the value of glasses for general symptoms. — Relief from nausea by the use of glasses. — Illustrative cases.

In common with many if not all ophthalmologists, I formerly prescribed prisms in combination with spherical glasses for the relief of asthenopia in a certain number of cases. For some years I have ceased to do so because I find no advantage in their use. They accomplish nothing that spherical or cylindric glasses will not accomplish, except in the very few cases of paralysis of the external ocular muscles, when they may sometimes be used to correct double vision, until the disease causing the paralysis has been cured. The double vision quite often seen in hypermetropia, or hypermetropic astigmatism, a diplopia which is not constant, may always be relieved by a correction of the error of refraction.

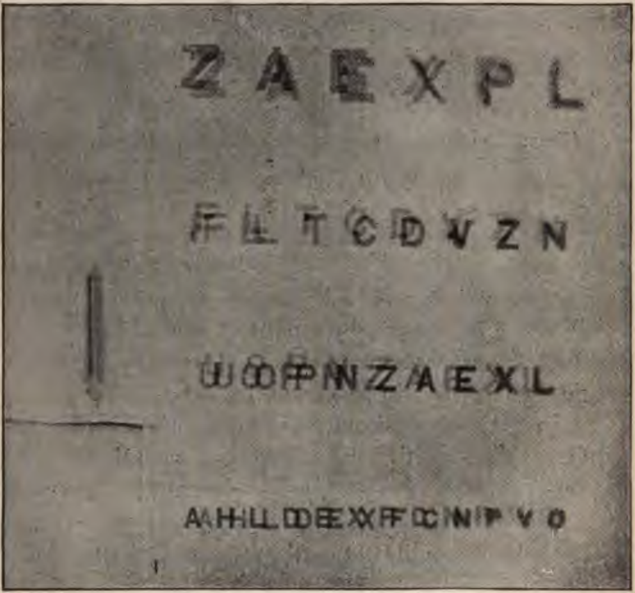

FIG. 21.—PHOTOGRAPHIC IMITATION OF MONOCULAR POLYOPIA.
G. J. BULL

Dr. G. J. Bull has shown that this so-called double vision is often to be described "as the imperfect superposition of a series of faint multiples of the original letter."[1] I believe that this is the correct view of quite a number of cases of *polyopia monocularis*. It explains the ease with which such cases are treated by correction of the error of refraction. The observer who will make himself astigmatic to a considerable degree will, in an instant, recognize this doubling of vision, which is the result of an uncorrected error of refraction in one eye, and has nothing to do with insufficiency of the muscles.

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[1] Transactions of the Ophthalmological Society of the United Kingdom, Vol. XVI, p. 204.

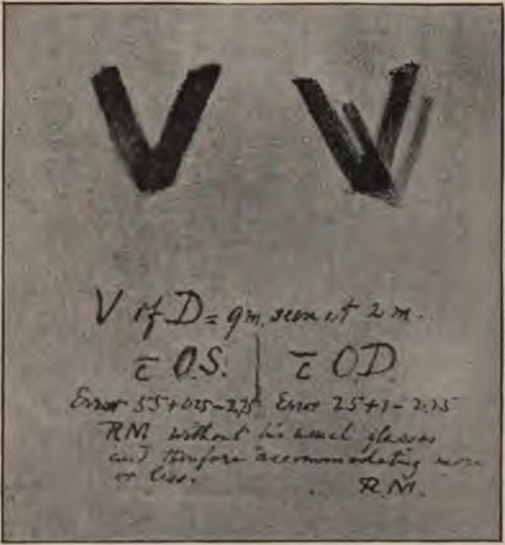
V of D = 9 m. seen at 2 m.
c̄ O.S.
c̄ O.D
Error 55+025-275
Error 25+1-2.25
R.M. without his usual glasses and therefore accommodating more or less.
R.M.

FIG. 22.—MULTIPLE IMAGES OF THE LETTER V, AS DRAWN BY A HYPEROPIC SUBJECT. G. J. BULL

The beginner in ophthalmology should ever keep in mind the truth first plainly set forth by Donders, for a time lost sight of, but finally brought out again into proper prominence by Alfred Graefe, of Halle, that the conditions and actions of the muscles depend upon the fixed conditions, that is to say, the refraction of the eye. Until that is corrected, if an error exist, it is impossible to speak correctly of muscular action.

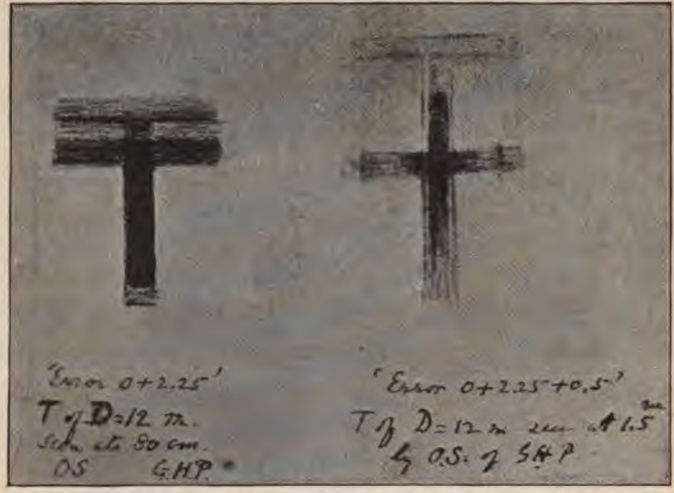

FIG. 23.—MULTIPLE IMAGES OF THE LETTER T, AS DRAWN BY A SUBJECT. G. J. BULL

The use of prisms, is based upon measurements of the power of the ocular muscles. I have long since demonstrated that just as many variations in the power of these muscles occur in eyes that have never suffered from asthenopia, as in those that are incapable of proper use. The power of the muscles depends upon the refraction, upon cataract, upon neurasthenia, diabetes, and other fixed conditions, or constitutional diseases. He who desires to improve defective eyesight, need not take prisms into account in his prescriptions. For the purpose of physiological study, the practitioner may be desirous of practising the method for

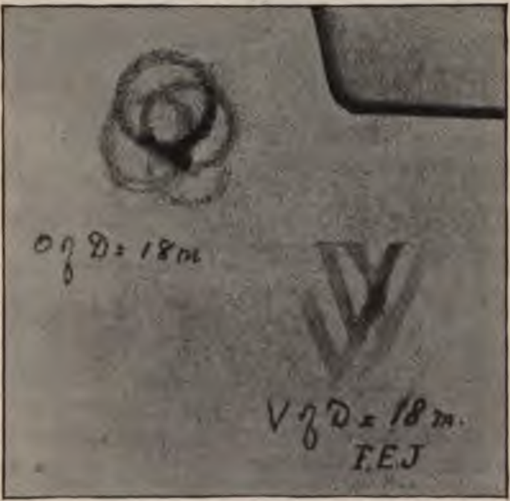

FIG. 24.—MULTIPLE IMAGES OF THE LETTERS O AND V, AS DRAWN BY A SUBJECT. G. J. BULL

measuring the power of the ocular muscles. If so, he will proceed as will be shown later on.

The use of prisms has also been attempted in decentration of lenses. The prisms thus introduced were to regulate the convergence, while the convex or concave glass attended to the accommodation. Giraud-Teulon was the first to recommend this systematic use of decentred lenses. Scheffler of Brunswick, Germany, in his treatise,[1]

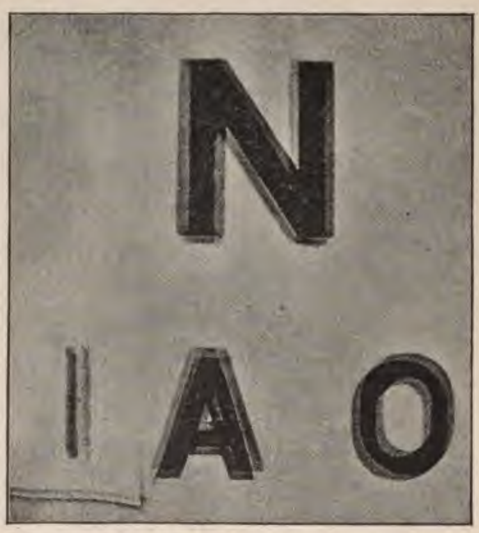

FIG. 25.—PHOTOGRAPHIC VIEW OF A LENS IN SECTORS, DECENTRED AND OUT OF FOCUS, AS SEEN IN CATARACT. G. J. BULL

translated by R. B. Carter, made much of this use of prisms. They were fairly tried by the profession, but they have been pretty generally abandoned. Carter[1] himself long ago gave them up, "save in a few exceptional cases." I have no doubt, although I am not positively informed as to this, that he has since given them up entirely. Certainly he who avails himself of our advanced knowledge as to the use of cylindric lenses, will not need to prescribe decentred or prismatic glasses. Carter states that Scheffler's researches into this subject were matters of mathematical analysis and calculation from which important data were neglected, as experience soon demonstrated. I gave a fair trial to decentric lenses, and also found no benefit from their use. This is also true of my experience with the other methods of using prisms. Weak prisms are but a placebo. Strong ones are unbearable and of more than doubtful value.

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[1] *Ocular Defects*, London, 1869.

TESTS FOR INSUFFICIENCY OF OCULAR MUSCLES

A prism with the base upward or downward is placed in front of one eye, and then the patient is caused to look at a cross (+) held at about the ordinary reading distance in front of the ey when he will observe two dots or cross-lines, on directly above the other, if the recti be of prope strength, but if insufficiency exists, these dots wi be separated laterally. If the insufficiency be o the internus, the image from the right eye will b on the left side, and *vice versa*. By placing othe prisms base inward before the eye, the dots ma be brought into the same vertical line. Th strength of the prism required will be the measu of the deviation. A candle may be used instea of a dot, when the test is used for a distance b yond the one employed in reading. Prisms a sometimes used to give the eyes strength by gym nastic exercises. If the desire be to strengthe the internal rectus, the base is placed outward This displaces the rays toward its base, and thos from the object will be deviated outward, and th image will be formed upon the retina outside o the macula. The eye will endeavor to overcom this by rolling inward, which motion, of cours pulls the macula outward. It is very doubtful this kind of exercise of the ocular muscles ha any curative value, although much was expecte of it at one time.

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[1] *Good and Bad Eyesight*, Philadelphia, 1882.

The dot test for insufficiency, sometimes fails to reveal a considerable weakness of the interni, and the following one may be resorted to when the first test, known as Graefe's test, fails to detect a weakness of the muscles.

A prism, base outwards, is placed before one eye, while the other is covered with a transparent red glass, and the patient is told to look at a candle placed some twenty feet away. If the prism be one of low degree, unless the muscles are very weak, double vision will be produced for an instant only, when the images will blend. The rays entering the eye through the prism are bent toward the base of the prism — that is, outward — and the image will fall outside of the *macula lutea*. This, of course, produces double images, which are blended by the action of the internal rectus, which rolls the eye inward and displaces the macula outward, to accommodate it to the displaced ray.

Now, if we reverse this procedure, and place a prism with its base inward before the eye, the light is bent to the inner side of the macula, and, if the muscle has sufficient power, the external rectus pulls the eyeball outward and displaces the macula inward, when the image can be formed upon it. The *adducting* and *abducting* power of the muscles, that is to say, the power of the external and internal recti, are thus tested. The average power of the external rectus, enables it to overcome a prism of 8°–10° of the internal of 19°–20° when regarding an object 18 feet distant. If by neither the dot test nor the one just described, weakness of the muscles be detected, we may believe that they have average power.

As has been said, persons who have never suffered from asthenopia exhibit great variations in the power of their ocular muscles. These tests are matters of very slight interest or value, although several very ingenious instruments have been invented for the purpose of measuring the deviations from what has been termed the ocular balance; while very serious essays and monographs have been written to prove that grave constitutional diseases depend upon a want of it.

For years, I spent much time in making Graefe's and other tests as to the power of the externus and internus especially, but I have abandoned them entirely, and I advise every practitioner to do the same. The time spent in this manner is simply wasted. As long ago as 1882, Carter[1] said of Graefe's tests and theories of insufficiency: "Later observations have neither confirmed his hypothesis nor established the value of his tests." With this view, my own experience became in accord at about the same time, after years spent in muscle testing, with some muscle cutting; and all this in connection with a careful study of the writings of Graefe, Loring, and the authorities of their time. If Donders had made his investigations of the fundamental importance of fixed conditions of the eyeball, a few years earlier, we should have been saved much valueless literature on the power of the external ocular muscles.

It is now, however, pretty generally conceded that organic diseases of the general system do not result from ocular conditions; but it remains true that uncorrected errors of refraction, in very many cases, produce symptoms that do not belong to those classified under the head of asthenopia. Attacks of migraine, nausea, headaches of a typical kind, often become lessened in frequency, and sometimes disappear, under correction of the refraction. Local diseases of the eyelids — blepharitis, styes, and so forth — often depend upon the same cause; but constitutional diseases, — epilepsy, diabetes, Bright's disease, and so forth, — never.

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[1] *Loc. cit.*, p. 149.

There are cases in which epileptic attacks have been, for a time, lessened in frequency by the giving up of drugs, and the employment of what may be termed suggestive ocular treatment; but, as the present writer can testify from personal observations, many, at least, of the much vaunted cures of epilepsy by operations upon the ocular muscles, and by correction of the want of ocular balance, have relapsed before even the accounts of the cases have reached all the readers for whom they were intended.

THE CURE OF HEADACHE, VERTIGO, AND OTHER SYMPTOMS, BY THE USE OF CORRECTIVE GLASSES

While there has been much of exaggeration in some of the claims that have been made for the cure of headaches, vertigo, and more serious affections, by the use of glasses, it still remains true that many *symptoms* that do not appear to be related to the eye, are often removed by the use of correcting glasses. The claims put forth some years since, that chorea depended upon an error of refraction, was necessarily abandoned when it was shown that chorea was cured without glasses — indeed, that it had been recovered from, when the use of glasses for hypermetropia and astigmatism was unknown.

In the same way, the extravagant hopes raised for the cure of headaches, and so forth, by the use of glasses, which have led to a frequent reference of grave constitutional disorders, such as epilepsy, to the accommodation and action of the ocular muscles, must finally be given up. Yet headache is often relieved more or less completely, by the use of cylindric glasses for the correction of astigmatism; and serious nervous symptoms have often disappeared in the same way after general treatment has been of no avail.

Did the scope of these pages allow, I could fill much space by the recital of many cases of this kind. A few only will be given. It therefore behooves the general practitioner to be able to make certain tests as to the refraction and accommodation in all doubtful neurotic cases. There is nothing absolutely new, although this is often forgotten.

in the claim that serious symptoms are sometime
relieved by the proper correcting glasses. It i
as old as Donders's first papers.

Mr. Bendalack Hewetson, of Leeds, Englan
has published a number of striking cases of relie
from sick headache, by the use of atropine an
the correction of astigmatism.

Noyes, Galezowski, Weir Mitchell, and other
long since wrote upon the subject, while Donde
himself was not unmindful of the good effect
proper correcting glasses upon despondent peopl

Some years ago I knew very intimately a youn
physician, of neurotic parentage on both side
who suffered severely at times from "blind hea
aches" — headaches that impaired his sight ser
ously for a short time, and made him very ill f
24 or 36 hours. He had no disease of his ey
beyond a slight degree of latent hypermetropi
After this had been corrected, and while he w
wearing glasses, for a year the headaches we
very much less frequent. He finally gave up h
glasses, and the headaches did not recur, but
was always rather feeble, and at last broke dow
and died from a series of affections, of whi
Bright's disease was one. His case illustrat

what I mean when I state my conviction that defects of sight are only one, and generally only a temporary, factor in the production of neuroses. Too much stress should not be laid upon the curative power of the correction of errors of refraction, or we shall often meet with cases that we cannot reconcile with theories of their influence or that of a want of equilibrium of the ocular muscles. I have known several celebrated people who have done good work without glasses, and without ocular treatment, whose eyes were never in a state of equilibrium, and whose refraction was not normal.

I have found not a few cases of troublesome asthenopia, unconnected or even associated with refractive error, in which incipient Bright's disease played an important part in causing the ocular symptoms. Even in young persons, in cases not responding to local treatment, an exact chemical and microscopical examination of the urine should be made. The presence of casts, sometimes clears up a diagnosis and gives indications for proper treatment, which may not only lessen the ocular symptoms, but greatly prolong the life.

The claim that a large proportion of the n roses are due to the eye, is a larger one than tha made by Donders when he issued his book. H recommended glasses for hypermetropia, astigmatism, asthenopia, as well as for myopia and presbyopia, and Graefe made great use of prisms fo the correction of muscular asthenopia dependen upon insufficient power of the internal recti; bu neither of these men appear to have dreamed o glasses as a panacea for headaches, dyspepsia, epilepsy, chorea, or uterine diseases, for all of whic they are now in some instances advised. Donder went very far in his statement that "hypermetropia is usually at the bottom of asthenopia. But his definition of asthenopia was a narrow on compared with that now often employed. It wa confined to "a feeling of fatigue and tension, . . especially above the eyes," with "indistinct an confused vision in reading, writing, and other clos work." It is hard to overestimate the value o Donders's work in tracing the frequent source c asthenopia to hypermetropia. He stopped suc practice as division of the external recti to reliev what was supposed to be spasmodic contraction c these muscles. His investigations have permitte sands of young people to become educate men and women — young people who, before the days of convex glasses for hypermetropia, were condemned to sheep-grazing and cattle ranches, without the comfort of even light reading; but he was conservative even in the face of his great discoveries, and did not recommend glasses even to "an elegant lady of twenty-two," under treatment for slight granulation, who had a manifest hypermetropia requiring a glass of 24 inches focal power for its correction, and he heads her case: "Hypermetropia does not always cause disturbance, and correction is then unnecessary" He details with a graphic pen an account of a reverend asthenope of fifty-two who has a "sad past and lives in a gloomy future," who, from fear of blindness, has not contracted a matrimonial alliance with which he believed his happiness for life to be connected — a man who left him as "one saved from destruction" by a change of glass of 20 inches focal distance to one of 7. He also carefully draws the line between apparent and true asthenopia, and pictures a nervous, weak little woman of thirty-three who cannot use her eyes, and yet who is not relieved by glasses.

In spite, however, of Donders's scientific reser in statement, I fancy that many an oculist since his time, has been disappointed in finding that he has not been able to cure the asthenopia which accompanied hypermetropia, by convex glasses alone although he thought that he had proved that the refractive error was at the bottom of his case In other words, although Donders does not appear to have had a glimmer of light that was to be thrown over all the domain of reflex nervous disease, by a study of errors of refraction and weak ocular muscles, we do not find even his moderate statement of the curative power o glasses sustained in every case; but I am not at all sure but that Donders has conferred as great a material blessing upon the human race, in teaching us fully as to the use of convex and cylindrica glasses, as was ever conferred by one man.

One of the sources of deception of those who expect too much of glasses, is found in the fact that there is a class of patients who invariably are relieved by any *new* treatment, and fondly imagine that the last remedy is to relieve them of symptoms that are sometimes constitutional and inherited, and from which there can never be anything more from our science and art than palliation. Neurotic they are born, and neurotic they will continue to be as long as they continue to live. Much as glasses have done for mankind, and much more as they will do, they by no means furnish a panacea for the ills of human existence.

A person suffering from headache, nausea, or any other symptoms likely to be remedied or mitigated by glasses, will usually get great benefit from full paralysis of the accommodation by the use of the sulphate of atropia.

The practitioner, however little he may know about the tests for the correction of imperfect vision, may easily get a good idea of the probable value of glasses by this simple procedure: The worst cases of spasm of the accommodation may be usually relieved by the instillation of a four-grain solution of the sulphate of atropia, into each eye, three times a day for a week, and generally three days are sufficient.

Those who see much of diseases of the nervous system, and who do not have convenient access to expert knowledge of the refraction, would do well to avail themselves more frequently of this simple test by atropia. The use of atropia in this way is the only means known of putting the eye a rest. The value of rest as a therapeutic agent i probably never overestimated.

CASES ILLUSTRATING THE VALUE OF GLASSES AN ALSO THE LIMITATIONS IN THEIR VALUE, I RELIEVING VARIOUS SYMPTOMS

One of the most interesting cases of relief fron troublesome symptoms by the correction of astigmatism, was that which occurred to me about year and a half ago. A bookkeeper, who ha consulted me two or three years before, an whom I had advised to wear glasses, not only a his work but at other times, made only a partia use of them, and I heard, through his father, o a symptom of which he had said nothing whe he visited me; namely, that he was unable to g to the theatre, or to any place of public amusement, for the reason that on his return hom and even before he left the theatre, he was alway attacked with nausea, which went on to vomitin and produced so much discomfort that he passe a very bad night after the attempt at enjoymen On hearing of this symptom, I was very muc interested in his case, and urged him to make m another visit. He did so, and I then persuaded him to wear the glasses which corrected his astigmatism, constantly, and to begin again to go to the theatre, and see if he could not now enjoy the play, without the subsequent ill effects. I reasoned that, after the fatigue of the day, the straining to see objects on the stage with an eye which was such a very bad optical instrument, might possibly be the cause of his symptoms. This proved to be the case. He was slightly affected on the first trial, when he wore his glasses, not at all on the second, and he remains perfectly cured, able to go to the theatre whenever inclined, without fearing the after-effects.

In the cases here reported, in which atropia was used and paralysis of accommodation secured, I would not now use a mydriatic, but I would trust entirely to the measurements of the cornea and to the test by glasses. These cases were treated before I used the ophthalmometer.

Case I. — *Pain in the back part of the eye on use for near objects.*

J. H., aged 23, a bookkeeper. For five or six years his eyes have troubled him. For two years he has worn convex glasses. He is a well-developed young man, in good health, except that he has "malaria" in the spring. He makes the peculiar complaint that the back part of his eyes gives him pain when he walks. When he takes off his glasses he has pains in his eyes and dizziness. Under the use of atropine, it was found that a glass of 24 inches focal distance was required to make him see $\frac{20}{20}$. A glass of 36 inches focal distance 1 diopter was ordered. A Faradic current of electricity was employed about and over the eyelids two or three times a week for about two months, and the troublesome symptoms disappeared.

This may be said to be a typical case of insufficient relief from glasses alone, although there was considerable hypermetropia. A Faradic current of electricity, with generous doses of moral suasion, brought this young man up to work with his eyes. He had been using glasses that fully corrected his hypermetropia, and a change was made to those allowing a little more of his accommodation to be employed. This may have had something to do with the result, but not very much, if any, for he did not get immediate relief.

CASE II. — *Frequent winking the chief symptom.*

M. B. W., aged 19, clerk. He is confined all day indoors as a salesman in a country town. His vision was found to be normal, and all glasses caused a blur.

He was put upon the use of arsenic, and advised to be more in the fresh air, but after a month he was not materially better. His ciliary muscles were then paralyzed by the use of atropine. After some days the refraction was found to be hypermetropic ($\frac{1}{30}$ in the right eye and $\frac{1}{42}$ in the left). He was advised to wear convex glasses, and, after a short time, the frequent winking of the eyes was completely relieved.

This is a case where it is probable that even a low degree of hypermetropia caused a spasm of the accommodation, and the frequent winking. Such a person, employed out-of-doors, would probably have had no trouble with his eyes, and yet it would have required much longer for the relief of his symptoms by general treatment alone, than was needed when the correcting glasses were employed, and the strain upon his accommodation greatly lessened. This patient will, probably, in time, give up wearing glasses until presbyopia occurs.

CASE III. — *A seamstress suffers for years, at more or less regular intervals, with severe neuralgic headaches; complete relief after use of cylindric glasses.*

Mary L., aged 26, has suffered as above, ever since she began to use her eyes constantly. It was suggested to her that her eyes might be the cause of the trouble. Her vision was found to be $\frac{20}{70}$. Under atropine, mixed astigmatism in one eye, and myopic astigmatism in the other were brought out, and with glasses (R. E. $+\frac{1}{30}^{c}$ 90° $-\frac{1}{48}^{c}$ 180°, L. E. $-\frac{1}{48}^{c}$ 180° $-\frac{1}{48}$) her headaches disappeared.

This case has been observed for ten years, and the relief afforded has been very great. It will be observed that the defect in vision is great, and that the refraction of the eyes is very dissimilar. I think the practitioner who hopes to cure headaches by the use of glasses will be disappointed if he starts out with the idea that he may accomplish much, unless there is a marked departure from the normal in the visual power. Since a slight degree of hypermetropia is a normal condition of the civilized human races, it cannot be believed, nor do statistics show, that headaches are often relieved where there is found, when the ciliary muscle is fully paralyzed by belladonna, only a low grade of hypermetropia without astigmatism.

A sister of the above described patient has similar eyes, and has had similar benefit from properly adjusted glasses.

CASE IV. — *A young woman engaged in coloring photographs has distorted vision and asthenopia in close work; glasses give only partial relief.*

Miss X., aged 23. For two or three years the patient has had much trouble in using her eyes. She has pains and confused feelings in her head. Glasses were fitted to her eyes by a competent surgeon, but she still suffers much. She has had much trouble from being reduced in fortune, and from unhappiness in her home. She has myopic astigmatism in each eye, and very slight insufficiency of the interni at 20 feet. She also suffers from uterine displacement, for which she is under the care of a gynæcologist. Great pains were taken to adjust the proper glasses, with which her vision is raised from $\frac{20}{50}$ to $\frac{20}{20}$, but she struggles along with her work with difficulty.

If the source of this young woman's headaches and diplopia was solely in her eyes, our task would be an easy one. But here we have overwork and worry and uterine disease, any one of which is sufficient, without myopic astigmatism, to cause headaches or diplopia. Here we must needs "minister to a mind diseased," and "raze out the hidden trouble of the soul," besides our adjustment of glasses. Even if we concede that uterine disease may be caused by an error of refraction or an insufficiency of the interni, it certainly would be still difficult to conceive tha worry from being obliged to work for one's living, instead of living at ease, was produced b the same cause.

Case V.—*Sick headaches; hypermetropia of hig degree; no relief from glasses.*

Mrs. A., aged 43. She has suffered from sick headaches for years, as have other members of the family. She has worn glasses for years, but the headaches recur. Her vision is $\frac{20}{20}$, but, although only just presbyopic, she requires a glass of sixteen inches focal distance to read No. I Jaeger at 8″. She has no insufficiency o the interni, no astigmatism, and is a married woman, sterile, but apparently in robust health, and has been for years.

Plainly some other cause than hypermetropia must be found for this case. Glasses will not cure it.

Case VI.—*A blow upon the head is followed by nausea, headache, and asthenopia; hyperopic astigmatism discovered; gradual relief.*

Miss R., aged 31, artist in oil-colors. This patient struck her head against a shelf—the top of her head—some two months before she consulted me, in September, 1883, and she states that she had nausea and headache at once, and since then she has been unable to use her eyes at close work. The blow was upon the left side of the head, about two inches from the median line and about four inches above the eye. Her physician writes me that she has been anæmic and hysterical, and, although he detected hyperopic astigmatism and adjusted glasses, her eyes are no better, although her general condition has improved. I confirmed the diagnosis, and, after a course of some months' rest, tonics, and general care, with use of her glasses, she gradually became able to again do a full amount of work.

This certainly is a mixed case. With a basis of general anæmia, a blow precipitates an attack of asthenopia. Galezowski described such cases some years since. Under atropine she had hyperopic astigmatism compound on one side ($+\frac{1}{60}^{c}\ 90^{\circ} = +$ 72); on the other, simple hyperopic astigmatism $+\frac{1}{48}^{c}\ 90^{\circ}$; but without atropine her vision was $\frac{20}{20}$, and she always "saw better," as she said, without her glasses, than with. No doubt the astigmatism and spasm of the ciliary muscle were ætiological or predisposing factors in this case, but they were factors only. Much was needed for her relief besides the adjustment of glasses. This patient fully recovered, and is a very successful artist.

CASE VII. —*A lawyer suffers from asthenopia; partial relief from prisms, still greater from cylindric glasses and electricity.*

Mr. M., aged 35, has been seen more or less for two years and a half. Has had asthenopia for five years. He is wearing a cylindric glass, with a prism of 2° base inward, before each eye, but with imperfect relief. He is in good health and vigor. He has insufficiency of the internal recti of 5° by Graefe's test. His eyes were put under the influence of atropia, and glasses fully correcting the compound myopic astigmatism were advised, as well as the use of the Faradic current of electricity about his eyes once a day. The severe symptoms finally subsided, and finally he reports that he has a fair and painless use of his eyes but that he occasionally finds need to make use of electricity. The prisms were abandoned.

This is not the only case where I found, long before I abandoned the use of prisms altogether, that the combination of prisms with the correcting glasses did not do as well as a full correction of the myopia.

CASE VIII. —*A lady has frequent headaches as long as she can remember; blepharitis ciliaris, myopic astigmatism; great relief from glasses.*

Mrs. R. L., aged 28, is a large, well-developed woman. She has three children. She has suffered from frequent headaches of a severe character since she was a child, and her eyelids present an unsightly appearance from inflammation of the hair follicles. She was found to have myopic astigmatism (R. E. — $\frac{1}{24} - \frac{1}{18}^{c}\ 10°$; L. E. — $\frac{1}{72} - \frac{1}{60}^{c}\ 170°$). Glasses were adjusted; the lashes were treated with bicarbonate of sodium and ointment of red oxide of mercury. For two years and a half she has had scarcely a headache, as she says, and her eyelids, which have been red since she had the measles at three years of age, are free from hyperæmia and retained secretion.

In 1876[1] I attempted to show that blepharitis ciliaris was usually, if not always, accompanied by errors of refraction, and that its cure or relief were greatly facilitated by their correction. Ten years of observation has confirmed this view to my mind, and I believe it is now quite generally accepted. In this case, as in so many others, local means without resort to glasses had been tried in vain. The relief of the headaches is now even more marked than the cure of the inflammation of the lids. One of the children of this lady also has decided error of refraction, and also blepharitis. It will be interesting to note if headaches also occur.

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[1] Transactions of the International Congress of Ophthalmology, New York, 1876.

CASE IX. — *Compound myopic astigmatism in each eye in a schoolgirl; good vision secured with glasses, but only partial relief from asthenopia.*

Alice M., aged 16. For three years this patient has been under the care of Dr. Emerson and myself, and, although we can find no adequate cause for the asthenopia, and glasses are fitted so as to raise her vision from $\frac{20}{100}$ and $\frac{10}{100}$, R. and L. eye respectively to $\frac{20}{20}$ each eye, she gets but partial relief. Her general health is good; the menstruation and bowels are regular.

It is, of course, possible to suppose many things as at work in this case to produce an unsatisfactory result. It may be a progressive myopia with attendant inflammation, and other possible causes will suggest themselves to my readers. Yet the case is substantially no different from many in which relief follows the use of glasses and general hygiene.

CASE X. — *Hypermetropia of a considerable degree; opacity of the capsule of the lens; no relief from glasses.*

Mrs. L. A., aged 21. For a few months this patient has complained of a spot before the right eye and of mistiness of vision. For a month she has not been able to use her eyes without pain. She is in good general health. Her vision is only $\frac{20}{40}$, and becomes $\frac{20}{20}$ by the use of convex cylindric glasses. A minute opacity of the posterior capsule of the lens is found with ophthalmoscope. Her eyes were put thoroughly under the influence of atropine, when the astigmatism disappeared, but quite a high degree of hypermetropia ($\frac{1}{20}$) appeared, and vision became $\frac{20}{30}+$.

This case is of some interest, as showing that there may be a spasm of the ciliary muscles in which one part of this ring of muscular tissue is more involved than the other, for an astigmatism of $\frac{1}{48}$ gave way on full relaxation of hypermetropia. After a fair trial for more than a year, this patient declares that her eyes are no better. This failure to give relief is perhaps due to some inflammatory process too subtle to be observed by the ophthalmoscope, yet indicated by the slight capsular opacity. It is quite common, however, especially in hypermetropic eyes, to find a minute opacity on the anterior capsule — an opacity superficial in character, and looking like a bit of pigment from the iris glued to the lens.

Such patients very often develop cataract as life goes on. Their asthenopia is dependent upon the imperfect ocular instrument with which they are working. An uncorrected astigmatism is perhaps provocative of capsular opacity.

CASE XI. — *Asthenopia for thirty years in a nervous subject; compound hyperopic astigmatism; never able to use his eyes without discomfort.*

A. B., aged 36, merchant. He states that his eyes have given him trouble ever since he began to use them. He has always had an aversion to using them. He is a well-developed, healthy-looking man, but he is preëminently nervous. He can scarcely sit still in a chair for half a minute. He has been wearing a convex glass for reading for ten years. The vision in the right eye is $\frac{20}{70}$, and in the left $\frac{20}{100}$. During an ophthalmoscopic examination the patient acts like a hysterical person. His eyes were put fully under the influence of atropine. Compound hyperopic astigmatism was found in each eye, but no other affection. He was advised to wear correcting glasses, both for distance and for near objects. For about six weeks I received weekly letters from this patient, who resides in Chicago, stating that he never could wear his glasses, but finally he settled down and said he was used to them, and continued to be so.

I cannot but think that cylindric glasses would have materially assisted this patient's vision years before. But I cannot believe that his nervousness was caused by the astigmatism, and I look for no relief from this constitutional condition. He was born neurotic, and neurotic he will die. I have seen one patient who suffered from well-marked chorea at one period of her life — chorea which followed acute articular rheumatism — from which she recovered fully, and not until several years after, was hyperopic astigmatism detected in one eye, and mixed astigmatism in the other. This was corrected, and great happiness bestowed upon her, but the glasses were not given until years after the recovery from the chorea.

CASE XII. — *Dizziness and double vision in a young boy; nearly complete recovery on the use of glasses.*

Master H., aged 12. Since he was a small child he has not been able to control the muscles of his eyes. He sees double when he looks at anything fixedly for five minutes. If he halts for an instant in reading, he sees double. His eyes pain on use, and he gets dizzy. His general health is good, but when the dizziness comes on he is often nauseated. His vision is found to be $\frac{20}{100}$ + in the right eye, and nearly $\frac{20}{20}$ in the other. The diplopia is crossed, showing insufficiency of the *recti interni*. After being some five days under atropine, he was found to be myopic in the right eye and emmetropic in the other. But no glass brought his vision up to more than $\frac{20}{50}$ with the right eye. A month after, a 1 to 25 D glass had been ordered for the right eye and a plane one for the left. He reported that he had no dizziness or double vision unless he took off his glasses.

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It is notoriously difficult to manage cases of asthenopia in which the refraction of one eye is markedly different from that of the other, and yet not every person with *anisometropia* has asthenopia. Many persons get on very well with one myopic and one hypermetropic eye. It is also remarkable how much may sometimes be done in causing such eyes to work together without difficulty. A patient of Dr. Loring's, a bartender, was known to wear a strong convex glass on one side over an eye from which the lens had been removed, and a strong concave glass on the other. He had some difficulty in learning how to mix drinks and to walk downstairs, but he finally succeeded after pouring many mixtures over his bar, and nearly breaking his nose from various falls from a misstep.

CASE XIII.—*Asthenopia for many years; under the care of many oculists, but no relief sufficient to enable her to read and sew; hyperopia in one eye, and myopic astigmatism in the other.*

Mrs. L. B., aged 38. This patient is neurotic and anæmic. After many trials under atropine, I advised a glass for each eye. The vision could be made $\frac{20}{30}$ in the right eye from $\frac{20}{40}$, and $\frac{20}{40}$ in the left (R. E. + $\frac{1}{20}$;

L. E. $+\frac{1}{48} - \frac{1}{42}{}^{c}\ 165^\circ$), and electricity was used, but, like all my predecessors, I failed to enable her to use her eyes after a trial of some months.

Case XIV. — *An unsteady head relieved by glasses.*

R. K., aged 44, lawyer. He states that he has had an "unsteady head" for some two years. He has been treated by various physicians without relief. His last physician advised him to have his eyes examined. He can give no clearer account of his symptoms than to say that his head is unsteady. He does not walk easily, from fear of vertigo. He appears to be in excellent health, and gives no history nor appearance of constitutional disease of any kind. His vision is $\frac{20}{30}$ in the right eye and $\frac{20}{20}$ in the left. He is found to have hyperopic astigmatism in each eye. He was ordered correction glasses. His symptoms were at once relieved, and, five months after, his wife reported to me that he was wearing his glasses, and that he was almost entirely free from all unpleasant symptoms.

Uterine Asthenopia — Locomotor Ataxia

Uterine asthenopia, or the asthenopia so often found in women suffering from serious uterine disease, I have never been able to materially alleviate. Neither have I seen any benefit, other than very temporary, in the correction of trifling errors of refraction in neurotic hysterical subjects, nor in attempting to relieve the weakness of ocular muscles, so often one of the early symptoms of locomotor ataxia. It is well to be on one's guard in reference to the weakness of ocular muscles, one of the early symptoms of this disease. The characteristic of the action of the external muscles of the eye, is that it is irregular, varying even from day to day, affecting different sets of muscles at different times. It is a common error of those who study and measure the power of the ocular muscles as a means of diagnosis, to overlook the serious disease of the nervous system, while they make voluminous records of the action of the muscles as measured by various exact but useless machines. In neurotics their maladies fly from one part of the body to the other. They locate their diseases first in one organ and then in the other. One of them, who was boasting of the cure of his eyes by his last oculist, when so many before him had failed, admitted that, while his eyes were all right, the "disease had gone to his stomach." Cures of such patients depend very much upon the mental characteristics of the attending physicians as well as of the patient. If the former is a sentimental optimist, with great faith in remedies, not scrupulously objective in his examination, and if he deals with feminine patients, or male patients with feminine characteristics, he will score many temporary successes, while a cool-headed practical surgeon, accustomed to believe very little, will fail from the start. Much depends, in the estimate of a cure of neurotic subjects, on the point of view.

Many thousands of hypermetropes live to become presbyopes without asthenopia. Only when the failure of accommodation occurs from senile decay, will they become aware, by the need of very strong convex glasses for close work, and the failure of distinct vision also, that they started in life with eyeballs of less focal power than many of their fellows. Some myopes go through life without ocular symptoms, while a long eyeball in others becomes a prolific source of evil, and finally leads to that appalling disaster, detachment of the retina. Thus I might go on. Our still imperfect knowledge does not always enable us to say what are all the factors in a given case of disease. That there are often many, and seldom one alone, is scarcely to be denied. A narrow specialism will never find any comfort in the study of the woes of the human body. The various causes of disease are too complex and concealed in very many, if not in the majority of cases, to be found in the abnormal condition or action of one organ. While the correction of errors of refraction and accommodation will do much to alleviate the asperities of human existence, it is not a panacea even for neuroses, much less for inflammatory diseases. In attempting to relieve general symptoms by treating one organ of the body, we should avoid scepticism on the one hand, and excessive confidence on the other. *Medio tutissimus ibis.*

A case of hypermetropic astigmatism, in which the astigmatism was not corrected at the time the manifest hypermetropia was discovered. Measurement with the ophthalmometer. Increased relief.

Miss A. H. consulted me in February, 1878, when she was nineteen years old, on account of asthenopia. I found that her vision was $\frac{20}{20}$ on each side, and she read equally well at a distance with or without glasses of 1 D or $+\frac{1}{36}$. These glasses were ordered. [illegible] grew up, married, had children, lived [illegible], reading and writing a great deal. [illegible] glasses, but never having, what she [illegible] perfect satisfaction from her eyes. [illegible]d from asthenopia dependent upon hypermetropic astigmatism. Her grandmother had blepharitis ciliaris for many years. What was the refraction of her eyes I do not know. I speak of all these members of the family, because I knew and prescribed for them all. Atropine was not used to paralyze the accommodation in the young lady's case, because she accepted a spherical glass, apparently strong enough to give her great relief, and she did get great comfort from the use of her glasses. She lived abroad until this year, and now, having reached the age of thirty-nine, consulted me on the 17th of November, 1898, in regard to her glasses. I found her vision $\frac{20}{20}$ − in each eye. She accepted a + 1 D. She could read No. I Jaeger at eight inches without glasses. She had a corneal astigmatism, by the ophthalmometer, in the right eye, of 1.50 D with the rule, and in the left of 1 D with the rule. Her vision became $\frac{20}{20}$ + with a $+ 75^{c}$ 90° on the right side with a + 50 spherical added, and on the left, $+ 50^{c}$ 90° with a + 50 added. These glasses were ordered. This patient writes me two months afterward that she has never been so comfortable in using her eyes.

Hypermetropia without Corneal Astigmatism

It is my experience of late years, that pure hypermetropia, with no corneal astigmatism, is rather the exception than the rule. Yet there is always a certain proportion of such cases. A few examples will suffice to illustrate this fact:

December 15, 1897. Julia J., aged 14. She states that her eyes pain when she uses them. She can see $\frac{20}{20}$ with each eye, and she has but half a diopter of corneal astigmatism. She can see equally well either with or without + 0.50 D glasses. These are ordered for her. There is no doubt that she had a much higher degree of hypermetropia than that which she exhibits by the subjective tests, but it is quite sufficient, in most cases of hypermetropia, to give the glass that is readily accepted, and not to attempt to correct the latent quantity.

December 29, 1897. Anna J., aged 20, complains that her lids smart on use of her eyes. She reads $\frac{20}{30}+$ with the right eye, and $\frac{20}{20}-$ with left, and + 50 makes her read perfectly well. She has a quarter of a diopter of corneal astigmatism. A glass of half a diopter is, therefore, prescribed for her, to be used when reading only.

January 4, 1898. Elsie T., aged 12. This little patient has headaches on use of her eyes. Her vision is $\frac{20}{20}$ with each eye, but she reads very slowly, as if she did not see the letters well, and much better with a + 0.75 D. She has a half a diopter of corneal astigmatism. She is, therefore, ordered + 0.75 D, with hygienic directions.

January 11, 1898. Mary R. S., aged 30, does not use her eyes except at her convenience, but she has asthenopia. Her vision is $\frac{20}{20}$ in each eye, and she has half a diopter of corneal astigmatism. She sees as well with a + 0.75 as without it. She is, therefore, ordered these glasses.

January 25, 1898. Henrietta H., aged 14, eyes blur and get red on use. Her vision is $\frac{20}{20}$ – with each eye. It is $\frac{20}{20}$ with + 75. She has half a diopter of corneal astigmatism. The ophthalmoscope shows that she has a much higher degree of hypermetropia than three-quarters of a diopter. She is, therefore, advised to wear + 1.

January 9, 1898. Jane D., aged 16, occupation, a student, has asthenopia, although she is wearing glasses. She is wearing a – 25 with a -25^{c} 90°. This shows that she was supposed to have compound myopic astigmatism against the rule, when these glasses were ordered. Her examination showed that she had a $\frac{20}{20}$ vision, without glasses, in either eye, and that she had half a diopter of corneal astigmatism, with the rule, — that she was not myopic, but accepted a + 0.50. Inasmuch as the patient was very neurotic, and not particularly strong, an attempt was made to treat her eyes without glasses. Accordingly, none were ordered, but the result is not known.

I am quite ready to admit that, in many such cases as the above, proper hygienic conditions would remove the necessity for any glasses. But where they are actually accepted, that is to sa where the patient sees just as well with them a without them, and especially if they are somewhat preferred, and the ophthalmoscope shows a considerable degree of hypermetropia, I do not hesitate to order the glasses that are accepted, for close work only. I do not find the results, however, at all as satisfactory as in those cases of asthenopia connected with astigmatism. Where vision is absolutely improved by convex glasses, there is never any question but that they are almost invariably of great service.

IRREGULAR ASTIGMATISM

Dr. Deynard[1] wrote an interesting paper on the great benefit of approximately correcting even irregular astigmatism with amblyopia, such as results from opacities of the cornea, as may be done by careful testing, and by the use of the ophthalmometer. Some of Dr. Deynard's cases are very striking. I can corroborate the importance of this subject from my own experience. The advantages of the correction of any form of astigmatism, even if it cannot be done with complete precision, are sometimes very great.

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[1] *Post-Graduate*, Vol. VII, p. 479.

ASTIGMATISM IN APHAKIA

In aphakia, due to cataract extraction, the greatest advantage accrues by correcting the astigmatism. I have seen vision that was only $\frac{20}{70}$ with spherical glasses raised to $\frac{20}{30}$ when the proper cylinders were added to them. This can be successfully done, in most cases, in three months after the operation. Changes in the curvature of the cornea may occur until this period is reached. There is no need of prescribing the unsightly glasses, in which the cylinder is cemented on the middle of the spherical glass. But with the periscopic or toric lenses, they may be made comparatively light and convenient.

CHAPTER VII

GENERAL REMARKS AS TO LENSES

General remarks as to spectacles and eyeglasses. — Periscopic and toric lenses. — Use of glasses in the amblyopia of strabismus. — Anisometropia. — The dioptric system for measuring glasses. — Bifocal or Franklin glasses. — Kind of artificial light that should be used for close work. — Summary of method in testing defective vision.

WHEN the proper lenses for the correction of an error of refraction have been prescribed, the work of the optician begins; but the practitioner who leaves all the details as to whether eyeglasses or spectacles should be used, the size of the lenses, and so forth, to him who manufactures and sells the lenses, will sometimes be disappointed in his results. Even in large cities, where opticians and good opticians abound, the prescribers of glasses should, in some instances, see the glasses over the patient's eyes. Mistakes in the numbers of the glasses are seldom made by the opticians. They have too many checks for that, but they are no always fully alive to the necessity of seeing tha the glasses are properly centred; that is to say that the centre of the glass is immediately in front of the pupil, that the bridges of spectacles or the holders of eyeglasses are comfortable, and so forth. There are also some opticians who venture, after a patient has a prescription for glasses, to go over the visual tests with the patient, in a manner as near that of a practised ophthalmologist, as they are able to. This is very much as if an apothecary were to examine into the symptoms of a patient bearing him a prescription, before compounding and delivering the medicines or dressings that have been ordered. There is a feeling among some authorities who prescribe glasses that spectacles, and not eyeglasses, should be generally worn. Spectacles are very inconvenient to many, on account of their sides causing unpleasant feelings as they rest behind the ears. To some persons they are very unbecoming as compared with

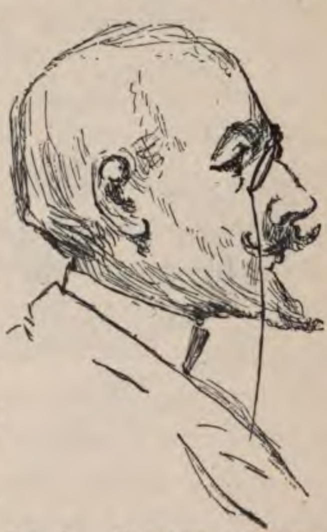

FIG. 26. — EYEGLASSES IMPROPERLY ADJUSTED FOR LOOKING AT A DISTANCE. AFTER G. J. BULL

eyeglasses. Much may be left to the patient in regard to the choice of frames for the glasses. In most cases there exists no necessity for the positive prescription of spectacles.

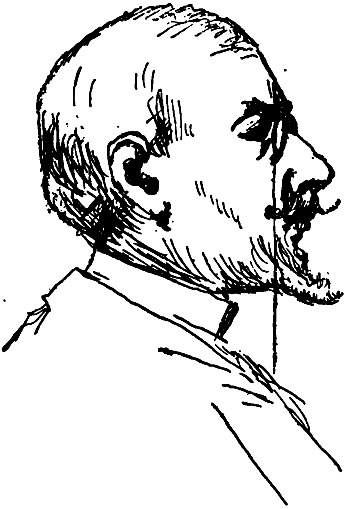

Fig. 27. — Eyeglasses properly adjusted for the Distance. After G. J. Bull

In this country, very few of those who actually fill the prescriptions for glasses, have any but what may be termed a salesman's knowledge about the construction of lenses, the principles of, and their use for impaired eyesight. The person who knows these things is in the manufactory, and the ophthalmologist of to-day, rarely comes in contact with the man who grinds the glass. But all of the opticians have pretty full information as to fitting the frames, so that they may be convenient and comfortable; but the practitioner must personally see that the glasses are as ordered, if he wishes to control his results. Patients may consult their own notions of comfort and appearance as to spectacles or eyeglasses, in all but exceptional cases. It is perfectly easy in adults, and even in some large children, to adjust eyeglasses instead of spectacles for those who use them only for reading, or occupations on near objects. When they are to be worn constantly, even, eyeglasses may be adjusted to most eyes, so that they will not blow off in the face of a strong wind, while riding on horseback, or walking on the deck of a ship, and the like. Some authorities lay stress upon very large glasses; but there is really no importance to be attached to a large lens. What is called No. 1 by the opticians, is large enough for adults, while children may have a size smaller. The advantage of larger glasses is altogether a fancied one, while they become much heavier by the increase in size, and are unsightly. Gold is the best material for frames and nose-pieces, simply because of the durability of the material, and its not being acted upon by wet and cold. Iron and steel are also serviceable, while nickel-plated steel frames do very well. Patients should be instructed, when beginning to wear glasses, as to how to take care of them. It seems elementary teaching to say to a patient that, in order to see well through a glass, it should be kept clean; but such instruction is often necessary. Japanese paper or chamois skin, are perhaps the best means of cleaning glasses. Besides rubbing the glasses every day, frames and glasses may occasionally be washed in a weak solution of *aqua ammonia*. Eyeglasses should not be kept doubled, but at full length. Cases are now generally provided that this may be done. Very few persons wearing eyeglasses require a cord or chain to keep their glasses on. So many improvements have been made of late years in the nose-pieces of eyeglasses, that this is seldom necessary.

Periscopic and Toric Lenses

Periscopic lenses, or those with one surface convex while the other is concave, have a great advantage over those that are convex or concave on both sides, *biconvex or biconcave.*

It is well to see to it that opticians furnish periscopic glasses even when low numbers are used. But in cases of compound or mixed astigmatism of a high degree, the periscopic principle in a so-called toric lens is of great importance in enabling the patient to wear a glass light in weight, and not so pronounced in appearance as the ordinary biconvex or biconcave lens. In aphakia also, after cataract operations, the toric lenses have a great advantage over the ordinary glasses. An intelligent and exact patient will derive much comfort from any decrease in weight possible in a glass. Javal, quoted by Dr. Bull,[1] has worn for years a toric glass made by Dorsch, of Philadelphia, which produced the effect of a spherical convex glass of 2.25 diopters, combined with a convex cylinder of 2.25 diopters. He finds the field of vision enlarged with the toric glasses. "One sees, in fact, as well across the border of the glass as across the centre." This advantage, added to that of great lightness, ought to make toric lenses everywhere prescribed for educated people. The opticians will furnish them on special prescription.

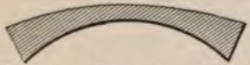

FIG. 28.—PERISCOPIC CONCAVE GLASS

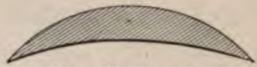

FIG. 29.—PERISCOPIC CONVEX GLASS

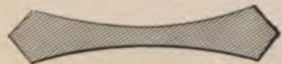

FIG. 30.—BICONCAVE GLASS

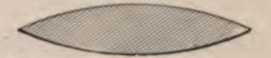

FIG. 31.—BICONVEX GLASS

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[1] *Lunettes et Pince-Nez.*

Among stupid and uncritical people, fine distinctions are not appreciated in glasses. The toric lenses were introduced to the profession of this country by Dr. Harlan of Philadelphia, and Dr. John Green of St. Louis. These writers have written repeatedly of their value, but as yet they are not generally prescribed, great as is their advantage. The name *toric* is from the Latin architectural term *torus, a large, round moulding at the base of a column.* The glasses are more periscopic than the ordinary ones.[1]

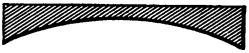

FIG. 32. — PLANO-CONCAVE GLASS

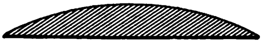

FIG. 33. — PLANO-CONVEX GLASS

GLASSES FOR THE REMOVAL OF AMBLYOPIA

Javal has taught the profession that much may be accomplished by proper correcting glasses in the amblyopia of strabismus. As is well known, the squinting eye usually, although not always, loses some of its visual power from disuse.

---

[1] Transactions of the American Ophthalmological Society, 1885, 1889; Harlan, Geo. C. The reader is referred to the following authorities for a full account of the toric lenses: Bull, G. J., *Lunettes et Pince-Nez*, Paris, G. Masson, pp. 28 *et seq.*

AMBLYOPIA FROM DISUSE OF THE EYE

Amblyopia Exanopsia.—Although this question has been much controverted, I deem it positively proven that the loss of sight in a certain class of strabismic eyes depends upon disuse of the eye. The question to be settled is, does the eye squint after becoming amblyopic, or does the squint produce amblyopia? I think the latter is true, and that amblyopia from disuse does occur. Certain it is, that the late Dr. Ely and myself, observed one case quoted by Javal,[1] where the amblyopia occurred after the squint was fixed. Dr. Johnson,[2] of Paterson, New Jersey, has reported striking cases, when after the loss of the fellow eye, an amblyopic one was brought up to full power simply by exercise. These cases are sufficient to settle the fact that amblyopia exanopsia, actually occurs, and that it may be recovered from. In such cases much may be accomplished in children, even by less stringent means than those adopted by Javal, in bringing up the vision with glasses which correct the hypermetropia and astigmatism.

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[1] *Manuel du Strabisme*, Paris, G. Masson, 1896, p. 239.

[2] Transactions of the American Ophthalmological Society.

If eyes are exercised even for fifteen minutes at a time three or four times a day, it is possible, as I have demonstrated in my own practice, to much improve the impaired vision. This is only true of strabismus dependent upon hypermetropia with difference of refraction in the two eyes, and when there is no organic disease of the eye, either in the media or the perceptive surfaces. To accomplish results in these cases, the parents must be intelligent and inflexible in their dealings with their children. During the periods of exercise of the amblyopic eye, the other must be securely covered so that no use can possibly be made of it. Besides this, training of the eyes with the stereoscope, by means of the cards prepared by Javal and John Green, is of great value.

ANISOMETROPIA — UNEQUAL REFRACTION IN THE EYES

While in carefully selected cases, occurring in intelligent, but not necessarily well-educated, persons, much may be done in anisometropia to secure single binocular vision, much time is often wasted and much annoyance caused to patients, by endeavoring to accomplish the impossible in fitting glasses to each eye when great differences in the refraction exist.

An adult person who has a vision of only $\frac{20}{100}$ with one eye, while the other has $\frac{20}{20}$ without a lens, or with a weak one, can perhaps never be made to use the eyes together in reading, sewing, or the like. No harm will result from this failure to use both eyes at once. The notion that when one eye "does all the work" asthenopia is more likely to occur, is wholly illusory. The case of watchmakers is one answer to this. They use one eye constantly on very fine objects with the aid of a glass, and my experience and that of others show, that comparatively few of them come to an oculist for relief. But the unanswerable argument on this side is, that scores and hundreds of people pass through their lives with perfect vision in one eye only, and are never particularly inconvenienced. A distinguished and hard-working statesman of this country who had only $\frac{20}{50}$ with one eye, while there was $\frac{20}{20}$ in the other, and who read with one eye only, told me that he did not learn of his defective vision in one eye, until he was in college, and that he never had suffered from asthenopia. With glasses, his vision could be made $\frac{20}{20}$ with the right eye, in which there was a high degree of hypermetropia, but he prefers not to wear them. These examples are very common. As an instance of what may sometimes be accomplished in securing single vision with two eyes, the following may be instanced:

A clergyman of 46 years of age has $\frac{18}{200}$ in the right eye without glasses, and $\frac{20}{40}$ with the left. With + 3 D + 3^c 20° he gets $\frac{20}{30}$ in the right eye, and with + 1.50 = 1.75 160°, $\frac{20}{20}$ + on the left, and he wears these glasses comfortably. With a corresponding increase in spherical glasses, he reads No. I Jaeger with each eye. Being accustomed to read manuscript when preaching, he uses a weaker pair for this purpose, and is comfortable in all occupations. This was after having given up the use of the right eye for some years, except for very large objects.

Per contra, I declined to endeavor to try to cause the following patient to read with the right eye:

She was a school-teacher 24 years of age. Her vision was $\frac{20}{70}$ in the right eye, and $\frac{20}{20}$ – in the left. She had 3 diopters of astigmatism *with the rule* with the right eye, and 1.25 diopters with the left. She read No. I Jaeger with great difficulty, not fluently. With the right eye her vision was improved with the appropriate glass, + 2.50^c 90°, but she found it very uncomfortable.

Vain endeavors had previously been made to enable her to use both eyes in reading, but they had been failures, and I advised that the effort be abandoned.

This is a case which, if it had been prescribed for in early youth, the amblyopia from disuse of the eye, might have been prevented. It will be observed in these cases that the one had $\frac{20}{20}$ – in one eye without glasses, while in the other, that of the clergyman, there was only $\frac{20}{40}$ in the better eye. Had the latter had $\frac{20}{20}$ in that eye, correction of the two, so as to cause them to act together, would not have been easy.

The difficulty of securing vision with each eye in anisometropia, is greatly increased when one eye has perfect vision without glasses. In adults, it is generally impossible. They can never accustom themselves to wearing glasses of such different refractive power, especially when they cannot see that they gain any vision or comfort by doing so.

THE DIOPTRIC SYSTEM OF MEASURING THE FOCAL POWER OF GLASSES, AS COMPARED WITH THE OLD SYSTEM OF MEASURING THE FOCUS BY INCHES

It is hardly necessary at this time to fully discuss the relative merits of the dioptric system for numbering glasses, and that used everywhere until within the last few years, when an inch was made the standard. The dioptric system is now all but universally adopted. The French metre instead of the inch is used. The metre is taken as the unit, and each metre is called a diopter, or a dioptric. This is written, 1 D. The French metre is about equal to 37 inches. This expressed in the old style would be $\frac{1}{37}$. It being difficult to divide 37, 36 is used. Four diopters = $\frac{4}{36}$. This, in turn, equals $\frac{1}{9}$, and so on. To find the power of a glass in diopters numbered in the old way, we have simply to multiply. We take as many thirty-sixths as there are diopters. Six diopters = $\frac{6}{36}$ = $\frac{1}{6}$ old system. To find what number of diopters is equal to a glass in the old numbering, we proceed as follows: There will be as many diopters as the number is contained in 36.

A glass of 6 inches' focal distance, or of $\frac{1}{6}$, is $\frac{36}{6} =$ 6 D, and so on. All the test cases have the two systems of numbering, so that even these simple calculations are unnecessary. The numbers of glasses by the old system, really indicate the radius of curvature of the surface of the lens, and not its exact refractive power. The great objection to these lenses, however, is the fact that the addition and subtraction of the focal power of the lenses lead us into fractions to a degree that causes much inconvenience.

In the new or decimal system this latter difficulty is fully overcome. The addition and subtraction of the power of the lenses becomes very easy. The cases containing trial lenses are now generally arranged on the dioptric system, although the equivalent in English or French inches is also given. The glasses begin with a quarter of a diopter, 0.25, and run up to 20 diopters. To illustrate the convenience of the new system we have only to take the example of a patient with hypermetropia who has become presbyopic. His hypermetropia is, we will say, 0.75 D, or $\frac{3}{4}$ of a diopter; he is forty-two, and his presbyopia requires about the same glass, which is equivalent to one of 49 English inches. If we add together the two of 0.75 D, we shall have 1.50 diopters, the glass he will need for reading — a much simpler operation than to add together two fractions like $\frac{1}{17}$ and $\frac{1}{49}$. Those who once employ the modern system will not readily, I think, return to the old.

BIFOCAL OR FRANKLIN GLASSES

There are many persons who are obliged to wear glasses to see distinctly at a distance, as well as with which to read. This chiefly occurs in hypermetropia, but there are also many myopic patients who require glasses both for a distance and for reading. Such patients sometimes find great comfort in wearing what are called *bifocal* or *Franklin* glasses. In these glasses the upper half has the lenses suited to the correction of the actual hypermetropia or myopia, and the lower half contains the glass needed for reading. Some-

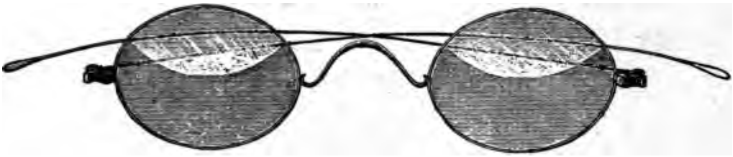
FIG. 34.—MODERN BIFOCAL GLASSES

times these glasses are made by dividing them into two equal parts. But most patients prefer those with the lower part larger than the upper. The opticians arrange these glasses by grinding the upper and lower halves of the same lens to different radii, when they are made larger above than below, or *vice versa*. When they are divided in equal parts, two separate glasses are employed. Some little practice is required to make these comfortable, but many persons find them very convenient, saving, as they do, the frequent change of glasses otherwise needed.

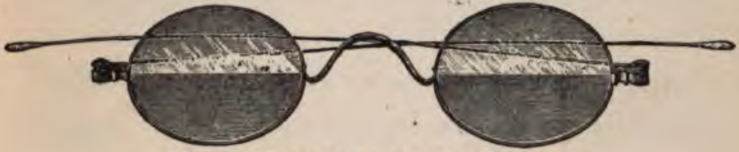
FIG. 35.—BIFOCAL OR FRANKLIN GLASSES

Patients undertaking to wear these glasses should be informed that they will have some difficulty at first, and, like persons wearing very strong glasses, they are to be particularly cautious in going downstairs to look downward and to watch the steps carefully.

Benjamin Franklin wore bifocal glasses, and they are often called by his name. Whether he invented them or not it is, perhaps, impossible to positively state. It is rather remarkable that opticians all over the world do not seem to be aware of the value of such glasses. The writer remembers an instance where an optician in London was taught by a gentleman from New York of the existence of such an arrangement of correcting lenses.

Franklin was slightly myopic, and had need of concave glasses to see at a distance, and convex with which to read. He gives an account of his own case in some posthumous works, quoted by Arthur Chevalier, *Manuel de l'Étudiant Oculist.*[1] Franklin states that he had to carry two pairs of spectacles, — one with which to read and then one, with which the next moment, in travelling he might like to look at the scenery He found this constant changing very tiresome. Then he had the glasses cut and united in the same frame. He remarks that he found the glasses very convenient at the table, when he wished to be able to see to eat, and also to look at the faces of the persons who spoke to him on the other side of the table. Thus, he says, "when the ear is not well accustomed to sound of the language, the movement of the physiognomy of the person who speaks aids greatly in comprehension. Hence, I understand French better, thanks to my glasses."

---

[1] G. J. Bull, *l.c.*, p. 79.

In a letter written to George Whately, August 21, 1784,[1] from Passy, Franklin says, after commenting on his friend's ability to write so small a hand without spectacles, "I am happy in the invention of double spectacles, which, serving for distant objects as well as near ones, make my eyes as useful to me as ever they were." After a search through this edition of Franklin's letters, I find no other allusion to these spectacles, although he gives advice in another place as to the strength of glasses to be used for reading. This extract does not make it appear that Franklin himself invented these glasses, but rather that he was happy in the invention of another.

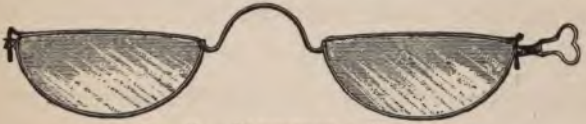

FIG. 36.—PANTOSCOPIC GLASSES

Pantoscopic glasses are glasses in which the upper part of the rims are so flattened, that the wearer can look over them in looking at distant objects. The glasses should also be set obliquely to the direction of the side-pieces, but perpendicular to the direction of the visual axis in reading. (John Green, *l.c.*)

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[1] *The Works of Benjamin Franklin*, edited by John Bigelow, New York, 1888, p. 55.

SUPPLEMENTARY GLASSES

A certain class of patients, especially those who have manifest hypermetropia and who are also presbyopic, may find great advantage in supplementary glasses, which they place over those which they require for seeing at a distance. For example, a patient who requires a glass of one or more diopters to see $\frac{20}{20}$, who only has $\frac{20}{40}$ without such a glass, and who is from forty-five to fifty years of age or more, will take great comfort in the use of a pair of supplementary eyeglasses which he places in front of the glasses which he habitually wears. When called upon to read a note, to glance over a newspaper, or, if a lady, to do shopping and so forth, they are placed in front of the glasses used for distance. Of course, for continuous work one pair of glasses, either the bifocal (Franklin) or those adapted for close work, will be pleasanter than the supplementary glasses, which are only practical for use for short periods of time. Those who are slightly myopic, and who constantly wear glasses to see clearly at a distance, also find the supplementary glasses useful, those which neutralize the concave glasses being generally what is required. Yet, inasmuch as many myopes can read well or see fine objects near at hand without glasses, they do not as generally find the supplementary as convenient as do hypermetropes, who are also presbyopic.

What with bifocal or Franklin glasses, toric and periscopic lenses, supplementary glasses, there is still a large field, not yet fully occupied, for the improvement of defective vision. It is truly remarkable, that even the educated and intelligent public still do not realize the full extent to which they may be assisted by proper glasses when they are required. But when it is remembered that it is only about forty-five years, that even a small part of the civilized world knew of the great advantages of cylindric glasses for a very common, but almost unknown, defect of vision, we cannot wonder that there is still widespread ignorance as to the details of aid with glasses.

THE KIND OF LIGHT ADAPTED FOR CLOSE WORK WITH THE EYES

The human eye in many instances tolerates much bad usage, and yet does its work for its possessor fairly well until the end of life. In such cases there must be alleviating circumstances, which mitigate the evil effects of improper care; for there is nothing more certain than that the same influences, acting on eyes of the same character, produce the same results. Among the many points upon which care should be exercised, lest harm come to the eye, is the character of light employed for close work, such as reading, writing, sewing, setting type, and the like. The picture of the boy stretched out before the open fireplace, and reading a badly printed book by the flickering light, is a romantic one, but, none the less, such a light, as well as that of the classical tallow-candle in the garret, are very poor sources of illumination, and very inadequate for what is required of the human eye. Defective eyesight, especially myopia, can often be distinctly traced to poor light. In this very active age, when excessive demands are made upon the eyes, the medical profession should be very alert to persuade school trustees and managers of railways to secure the best light possible for students and travellers. Electric light, well guarded by a shade or frosted lamp, so that the image of the light is not thrown directly upon the eye, ranks first in sources of illumination. Gas and oil lamps are decidedly inferior, but if well chosen and their flame be well shaded they are excellent lights, now that modern ingenuity has provided such good lamps.

The conditions for reading by artificial light should be made, as far as possible, like those obtained in reading indoors by ordinary daylight. The room should be generally lighted. It is a mistake in a library, public or private, to light up only the small space in which the work is being done. The whole room should be illuminated, while not made as light as day in the open air, — that would be too glaring, — but so well lighted that the reader or worker does not turn from a brightly illuminated page or piece of sewing or embroidery to a dark space: such a sharp contrast is not adapted to pleasant use of the eyes. It is unfortunate for those doing business in large cities and towns, but sleeping in the country, that they feel obliged to read newspapers and magazines, many of them badly printed, on suburban trains, passing through variously illuminated scenes, perhaps in and out of tunnels, at the best not too well lighted. It is probable that much of this kind of reading is harmful to many eyes, although many people continue to practise it throughout their lives without appreciable harm. Books and magazines printed with good black ink on paper not too highly glazed, are certainly very comfortable to the eye, and, without doubt, such advantages tend to conserve the vision of those who secure them. Care given to the proper conditions of illumination and paper and ink and type will be of great general service, and save us from becoming a myopic and amblyopic race. It may be added to this, that light coming from the left side and from above and behind the worker is to be preferred. Besides all this, as has often been pointed out, students and others working at desks or tables should always have those that are adapted in height to the size of their bodies, so that they may not stoop over too much in reading or writing. In libraries and schoolrooms, care should be taken that these conditions be secured. The schoolhouse wedged in between high buildings of a crowded district, and the "sky scrapers" of New York and other cities, are not adapted to preserve our race from being one with defective eyesight. In the case of very high buildings in business centres the lower stories must often be artificially lighted even during the hours of daylight in ordinary buildings. Many of the vaunted advantages of modern civilization are made of null effect by their environment. In the case just mentioned, the workers in the top stories secure their light and air at the expense of their neighbors on the lower floors, who have an inadequate supply of each. The moral of all this is, that the community that desires to secure the full use of the eyes of its children and wage earners must place them under conditions favorable to an unembarrassed use of what is truly the *light of the body*.

A Summary of General Rules as to the Adaptation of Glasses for the Correction of Impaired Eyesight

A fitting conclusion to this volume, may be a brief recapitulation of what has been said in the preceding chapters as to the principles at the basis of fitting glasses to the eye.

First. An exact examination should be made of the patient's eyesight by the test-cards.

Second. If the vision be $\frac{20}{20}$ or $\frac{20}{20}-$ in each eye, the next step will be to measure the cornea. If 1 diopter of corneal astigmatism *with the rule* be found, even if the patient's vision is $\frac{20}{20}$ without glasses, it will be safe to order a glass expressing half the quantity, that is, one of one half a diopter +0.50. If there be even 0.25 D *against the rule,* this should be corrected. If presbyopia exist, the proper cylinder should be added to the spherical glass.

Third. If the vision be only $\frac{20}{30}$ or less, a very careful examination should be made for corneal opacities, opacities of the lens, or changes in the back part of the eye. If the media are found perfectly clear, then the existence or absence of corneal astigmatism should be determined by the ophthalmometer.

Fourth. If the ophthalmometer be not used, it will be necessary, in order to detect latent astigmatism, as well as latent hypermetropia, to use atropine or some other mydriatic, according to the rules already given.

Fifth. When the ophthalmometer shows the axes to be either 90° or 180°, it will be very easy to prescribe the proper glass in one sitting. But, if the axis be oblique, subjective examinations with cylindrical glasses will sometimes require two or three sittings. These examinations, in a vast proportion of cases, will agree with the results of the ophthalmometer. If not, very careful measurements should be taken to remove the discrepancy if possible. If this cannot readily be done in two or more days, it will be safe to prescribe according to the readings of the ophthalmometer unless the discrepancy is very great.

Sixth. If there be no astigmatism, or not more than 25 to 50 diopters with the rule, the proper spherical, concave, or convex glasses should be ordered.

Seventh. When the vision is very slightly defective, and no cause is found for it in the cornea, the lens, or the other parts of the eye, we cannot be sure whether it be due to hypermetropic or myopic astigmatism, until the tests are made with glasses. Even in young subjects, when the ophthalmoscope shows distinctly that they are myopic, and concave glasses are accepted, I am willing to prescribe them; but if the fundus appears to be hypermetropic, even if they decidedly prefer concave glasses, atropia should be used to correct possible spasm. These cases are entirely exceptional.

Eighth. Considerable care should be given to the frames ordered for the glasses, but it is not proper to insist that spectacles should be worn. Eyeglasses, if well chosen, may be worn by all adults or intelligent young persons, even when a considerable degree of astigmatism exists.

It should be borne in mind that these rules apply only to cases that are positively those of errors of refraction, and which do not belong under the category of Diseases of the Eye. Where a disease of the cornea, lens, or vitreous humor, or of the retina exist, all rules as to the choice of glasses are flexible and approximative. The relief from them, if any at all, in cases of errors of refraction complicated by disease, can only be partial and not entirely satisfactory.

No. 1.

The Gallic tribes fell off, and sued for peace. Even the Batavians became weary of the hopeless contest, while fortune, after much capricious hovering, settled at last upon the Roman side. Had Civilis been successful, he would have been deified; but his misfortunes, at last, made him odious in spite of his heroism. But the Batavian was not a man to be crushed, nor had he lived so long in the Roman service to be outmatched in politics by the barbarous Germans. He was not to be sacrificed as a peace-offering to revengeful Rome. Watching from beyond the Rhine the progress of defection and the decay of national enthu-

No. 2.

siasm, he determined to be beforehand with those who were now his enemies. He accepted the offer of negotiation from Cerialis. The Roman general was eager to grant a full pardon, and to re-enlist so brave a soldier in the service of the empire. A colloquy was agreed upon. The bridge across the Nabalia was broken asunder in the middle, and Cerialis and Civilis met upon the severed sides. The placid stream by which Roman enterprise had connected the waters of the Rhine with the lake of

No. 3.

Flevo, flowed between the imperial commander and the rebel chieftain. — Here the story abruptly terminates. The remainder of the Roman's narrative is lost, and upon that broken bridge the form of the Batavian hero disappears forever. His name fades from history: not a syllable is known of his subsequent career; everything is buried in the profound oblivion which now steals over the scene where he was the most imposing

No. 4.

actor. The contest of Civilis with Rome contains a remarkable foreshadowing of the future conflict with Spain, through which the Batavian republic, fifteen centuries later, was to be founded. The characters, the events, the amphibious battles, desperate sieges, slippery alliances, the traits of generosity, audacity, and cruelty, the generous confidence,

No. 5.

the broken faith, seem so closely to repeat themselves, that history appears to present the self-same drama played over and over again, with but a change of actors and of costume. There is more than a fanciful resemblance between Civilis and William the Silent, two heroes of ancient German stock, who had learned the arts of war

No. 6.

and peace in the service of a foreign and haughty world-empire. Determination, concentration of purpose, constancy in calamity, elasticity almost preternatural, self-denial, consummate craft in political combinations, personal fortitude, and passionate patriot-

No. 7.

ism, were the heroic elements in both. The ambition of each was subordinate to the cause which he served. Both refused the crown, although each, perhaps, contemplated, in the sequel, a Batavian realm of which he would have been

No. 8.

the inevitable chief. Both offered the throne to a Gallic prince, for Classicus was but the prototype of Anjou, as Brinno of Brederode, and neither was destined, in this world, to see his sacrifices crowned with

No. 9.

success. The characteristics of the two great races of the land portrayed themselves in the Roman and the Spanish struggle with much the same colors: twice a Batavian republic took its

No. 10.

rank among the leading powers of the earth. Claudius Civilis was a Batavian of noble race, who had

No. 11.

served twenty-five years in the Roman armies. He was a soldier of fortune, and had fought wher-

No. 12.

Roman armies. He was a soldier of fortune, and had fought wherever the Roman

No. 13.

eagles flew; after a quarter of a century's service, he

No. 14.

was sent in chains to Rome, and his brother

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